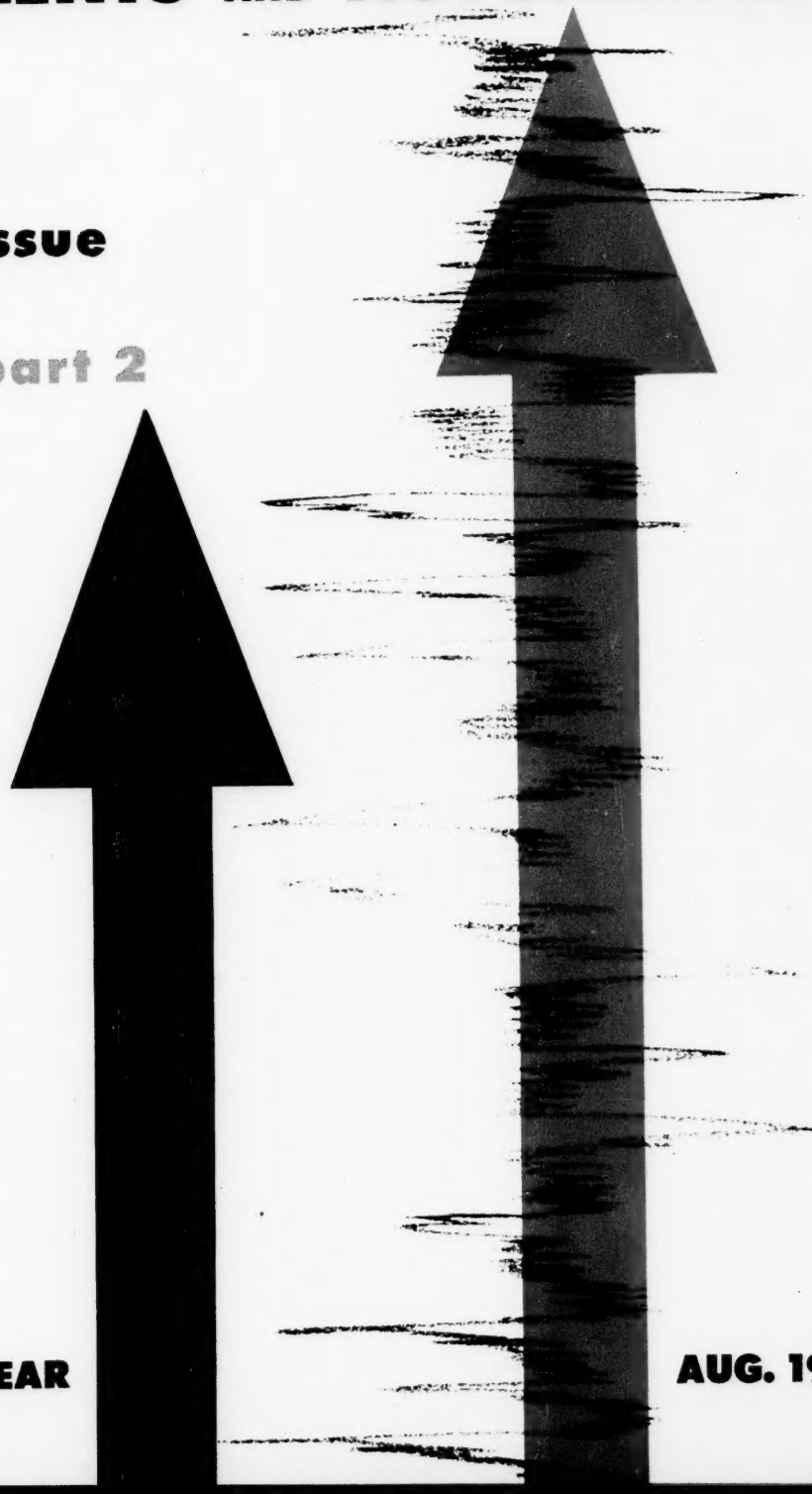
INSTRUMENTS AND AUTOMATION

ISA show issue
scanners
recorders part 2



INCLUDING: INSTRUMENT MANUFACTURING • JOURNAL OF THE SCMA • SIMULATION COUNCIL NEWSLETTER

OUR 31ST YEAR

AUG. 1958

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The United States Testing Company, Inc., established in 1880, is an impartial, authoritative testing and research organization serving all Industry. It offers, on an international scale, these services:

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For more information circle 1 on inquiry card.

LEWIS PORTABLE PYROMETER POTENTIOMETERS

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ACCURATE, DIRECT-READING, EASILY-OPERATED INSTRUMENTS, WITH ELECTRICAL COLD-JUNCTION COMPENSATION.

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  Model 14PO (illustrated) with high and low temperature scales.
  Model 78PO with one temperature and one millivolt scale or two temperature scales, for different thermocouple materials.
- Housed in a sturdy hardwood case, approximately 11⅜" long, 10" wide and 7⅞" high. Weight approximately 17 lbs., shipping weight 20 lbs.
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For more information circle **2** on inquiry card.

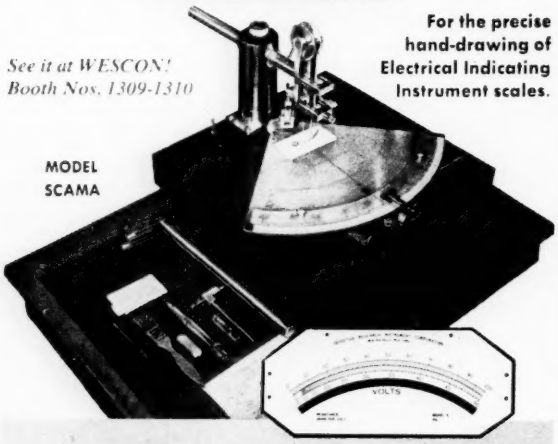
"The accuracy of an instrument is no better than its calibrated scale."

SENSITIVE RESEARCH SCALE DRAWING MACHINE

See it at WESCON! Booth Nos. 1309-1310

For the precise hand-drawing of Electrical Indicating Instrument scales.

MODEL SCAMA



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The Model SCAMA is designed for use by ***military and industrial personnel engaged in the repair and maintenance of electrical indicating instruments.*** It is an exact duplicate of the scale drawing machines used in SRIC's own production laboratories for the past 31 years.

Drawing scale calibration lines

Wherever the efficient in-plant repair of indicating instruments is a necessity, the economies of owning a scale drawing machine are readily apparent. The best craftsmen, furnished with the finest electrical standards, are still inadequately equipped if they lack the means necessary to "wrap the job up" by restoring an instrument to its original accuracy. It is unfortunate that the one thing that is usually missing, is the equipment to correct or re-draw an instrument's scale.

The Model SCAMA is furnished complete with all the necessary accessories to draw and print any flat scale plate to infinite accuracy. Included in its price is a 40-hour instruction course at SRIC's plant.

If you are an organization or group actively engaged in the repair of electrical indicating instruments, we urge you to investigate further the potentialities of the Model SCAMA.

SENSITIVE RESEARCH INSTRUMENT CORPORATION

NEW ROCHELLE, N. Y.

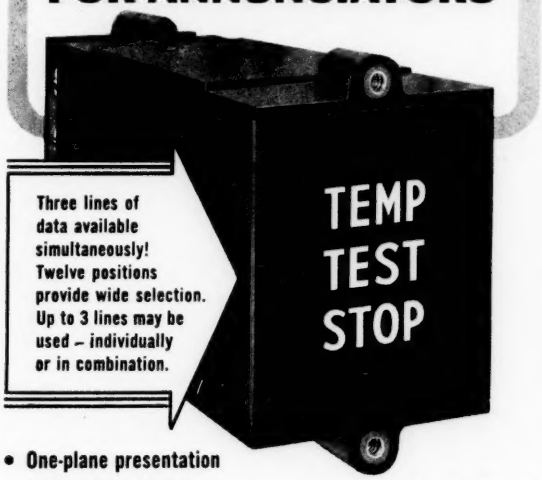
Symbol of Quality

ELECTRICAL INSTRUMENTS OF PRECISION SINCE 1927

For more information circle **3** on inquiry card.

IEE *announces a new*

MINIATURE DISPLAY FOR ANNUNCIATORS



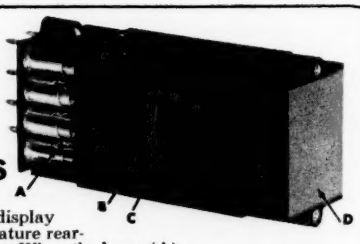
Three lines of data available simultaneously! Twelve positions provide wide selection. Up to 3 lines may be used – individually or in combination.

Viewing Screen And Data Shown Actual Size.

- **One-plane presentation**
- **Data uniform in size**
- **Faster and easier to read**
- **Quickly seen from any angle of viewing**
- **Modular type construction**
- **Size: 1-9/16" wide, 2-5/8" high, 5-1/8" deep**
- **Data of your choice – For Example: PITCH, ALT, BANK, TSTR CHK, END-END, PT-PT, COMPLT, MALFNCT, IN PROG, etc.**

Here's a new type miniature display for annunciators that offers greater flexibility, convenience, and savings in time, money, and labor. Small in size and light in weight, it is designed for those annunciator applications where simultaneous data is required in a fast, easy-to-read method. Twelve positions per unit provide wide selection of desired data. Available as a single unit, the IEE miniature display may be assembled in groups ready for panel mounting.

HOW THE IEE DISPLAY OPERATES



The miniature display utilizes 12 miniature rear-projected images. When the lamp (A) at rear of the unit is lighted, it projects the corresponding data on the condensing lens (B) through a projection lens (C) onto the viewing screen (D) at the front of the display.

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AUTOMATION: The use of devices—mechanical, pneumatic, hydraulic, electrical and electronic—for making automatic decisions and efforts.—MHA

AUGUST 1958

31

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EDITORIAL

Major Manoel Felix de Mayo Behar, 1351

FEATURE ARTICLES

Scanners, 1352

A SURVEY of available scanning devices using mechanical, electrical, electronic, pneumatic, and optical techniques

Distillation Column Dynamic Characteristics, 1357

PROBLEM: to simulate distillation-column dynamics on an analog computer

Recorders, 1360

TEN TABLES list comparable specs for available commercial recorders

Pressure Scanning System, 1366

F. MICHAELS and P. STRAIGHT—a pressure scanning system using one high-speed high-accuracy transducer and a scanner can accurately measure large numbers of pressures varying over wide ranges

Commutation Switch Developments, 1368

GEORGE P. BENTLEY and SUMNER ACKERMAN—the basic sampling-switch considerations that instrument engineers must ponder

Electronic Circuitry, 1371

M. H. ARONSON and C. F. KEZER—two more basic circuits

Automatic Shut-off Valves for Gas and Oil Transmission Lines, 1373

CHESTER S. BEARD—an important group of valves is used by the gas industry for emergency control in transmission and distribution lines in oil-field gathering systems

Continued on page 1276

Designed with the Look of Tomorrow by Raymond Loewy Associates

NEW PARTLOW MFS TEMPERATURE CONTROL

New Looks, Convenience, Efficiency for Your Process Equipment

Striking as they are, good looks are only part of the story of Partlow's spectacular new control. Inside and out, the MFS is as rugged and efficient as a temperature control can be, its tough mercury-actuated element having been built to retain sensitivity and accuracy even under extreme conditions. Convenient, too! You can interchange the mercury element right out in the field . . . no factory adjustment is required.

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THE PARTLOW CORP.
Dept. IA-858, New Hartford, N. Y.

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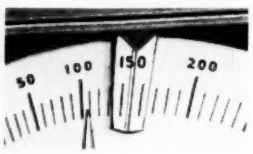

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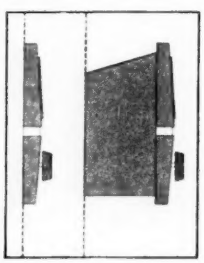

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Combustion Safeguards
Timers Limit Controls

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INSTRUMENTS and AUTOMATION

VOL. 31, NO. 8 • AUGUST, 1958

Continued from page 1275

The Journal of
THE SOUTHERN CALIFORNIA METER ASSOCIATION

Orifice Metering 1378

HARVEY ELAYER—covers orifice metering fundamentals including basic derivation of head-velocity relationship

THE SIMULATION COUNCIL NEWSLETTER

The Avco TAVET (Temperature Acceleration Vibration Environmental Tester), 1385
ALSO covers six other papers delivered at Eastern and Central meetings

OTHER REGULAR FEATURES

Letters to the Editor	1278	Books	1328
Trends	1285	New Instruments	1392
News	1294	New Plants and Mergers	1430
Stock Report	1298	People in the News	1432
Briefs	1306	New Literature	1434
Panhandle Pete	1315	Advertisers' Index	1448
Events	1323		

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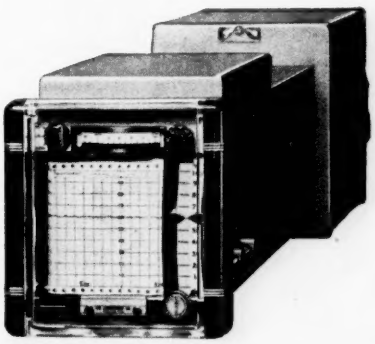

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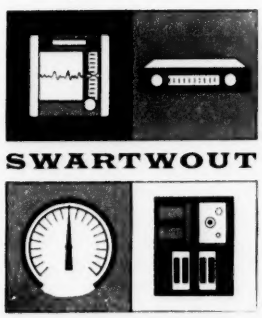

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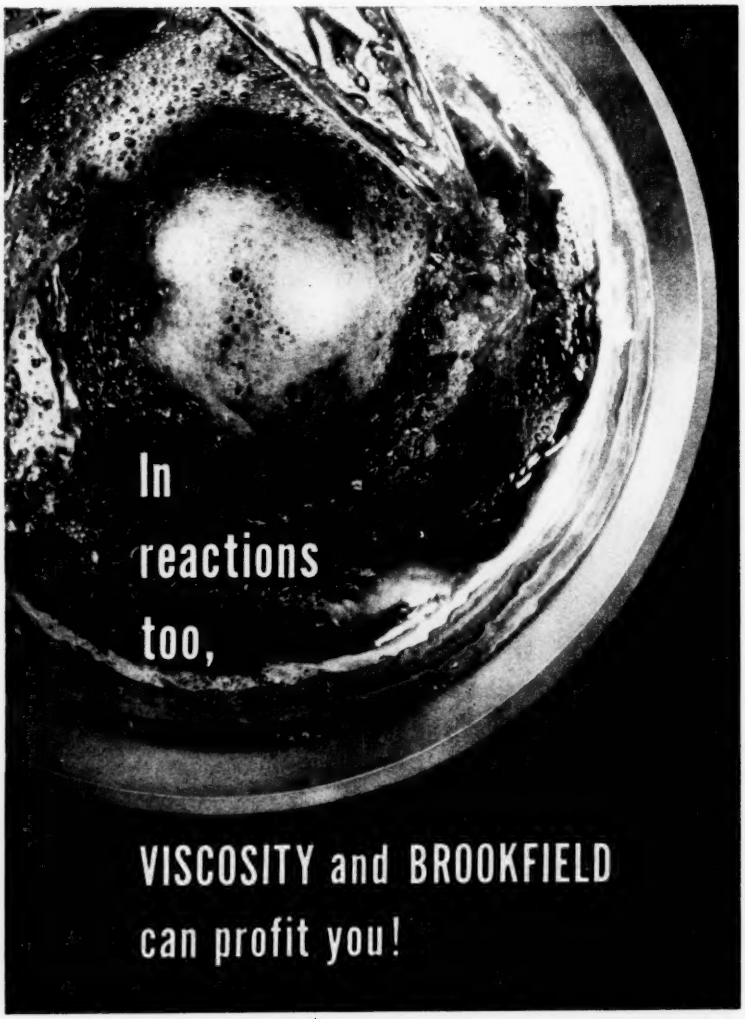

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See this equipment in operation at the ISA Show—Booth 1655

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to the editor

Editor, I&A:

We have seen your June issue which contains your article on Alphanumeric Readout Indicators.

We here at Veeder-Root think you people did a very good job in this instance and would like very much to write and congratulate those directly responsible.

G. M. Isbell
Veeder-Root Inc.
Hartford, Conn.

This was staff-written. Glad you liked it.

Editor, I&A:

We greatly enjoyed your "Introduction to Recorders" in the May issue of *Instruments and Automation.*

You mentioned a Swedish jet recorder. We are interested in this recorder and would appreciate any information that you might give us.

M. D. McCarty
Geophysical Laboratory
Magnolia Petroleum Co.
Dallas, Texas

This is the Mingograf made by Aktiebolaget Elema, Stockholm, Sweden.

Editor, I&A:

A note on manufacturing of instruments in Israel has come to our attention through the section "Trends" of the April 1958 issue of *Instruments and Automation.*

This note claims "that no instrument manufacturing industry yet exists etc."

May I contradict this erroneous statement by mentioning that Israel is an instrument manufacturing country. Watt-hour meters, water meters and pressure indicators of a quality not inferior to those produced by world famous firms, are actually produced in Israel.

We regret the misleading information you have obtained on this subject.

M. Medwied
Documentation Department
Israel Mining Industries Laboratories
Haifa-Israel

Sorry!

Editor, I&A:

As leading Australian manufacturers of Electrical Indicating Instruments, we are very interested in your reference to this industry in the

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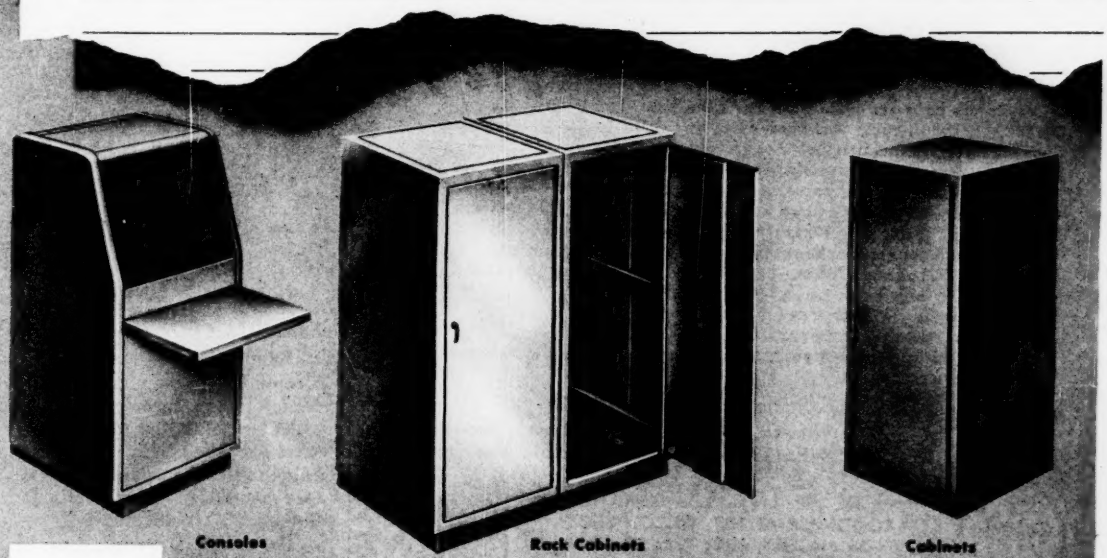

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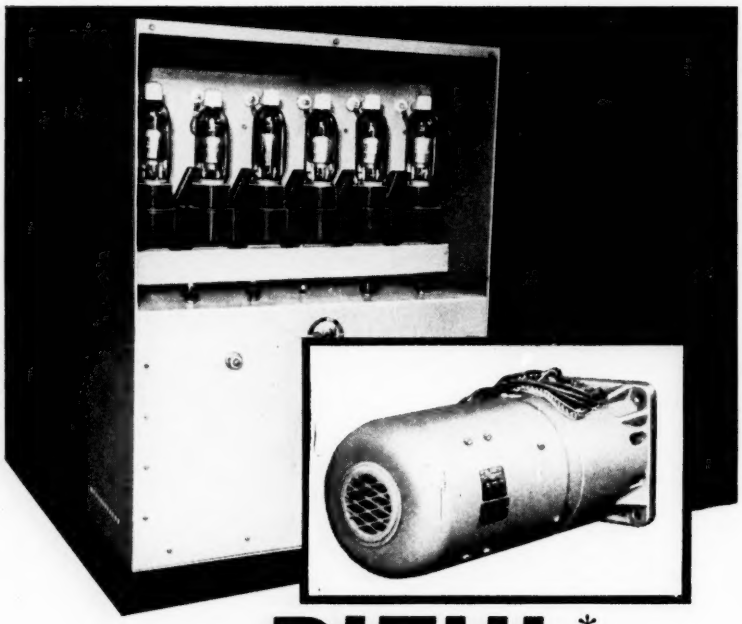

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LETTERS—CONTINUED

April 1958 issue of *Instruments and Automation*, under "Trends."

We are forwarding under separate cover our latest Electrical instrument Catalogue and other illustrated literature which we trust will be of interest. We also manufacture Rotary-Multi Point Switches, bi-metallic Thermometers, Radio-electronic and Electrical equipment.

We supply a comprehensive range of Switchboard and Panel Instruments capable of fulfilling most Australian requirements in this field. We have often considered the possibility of manufacturing temperature controllers, thermostats and other control equipment which would fit in with our current production programme. Accordingly, we would welcome an approach from an American Company interested in the manufacture of such equipment in Australia.

We are subscribers of long standing to your excellent publication which is of considerable value in keeping abreast of overseas developments.

E. S. Palmer
Chief Engineer
Paton Electrical Pty. Ltd.
Ashfield-Sydney-Australia

Editor, I&A:

The inequality signs are reversed in equations (4a) and (4b) of my article on Square Root Approximation (June, *I&A*, p. 1042). They should read as follows:

For $B^2/A^2 \leq 0.5$:

$$\sqrt{A^2 + B^2} \approx A + 0.5\ B^2/A \quad (4a)$$

For $B^2/A^2 \geq 0.5$:

$$\sqrt{A^2 + B^2} \approx 1.1A + 0.3\ B^2/A \quad (4b)$$

Leslie R. Axelrod.
Cook Research Laboratories Division
Morton Grove, Ill.

Editor, I&A:

[Referring to the article "Optical Strain Gage Standard" in March *I&A*.] Two extensometers are used in order to insure that the strain is constant over the length of the wire gage being tested. The work at this laboratory should be credited to Jack J. Shrager.

The Aeronautical Structures Laboratory has done considerable work in the development of a high-temperature strain gage. In December 1957, we conducted a symposium on elevated strain gages at which we reported our progress. The symposium was attended by approximately 300 scientists from all parts of the United States and from Canada and England. It is planned that the papers will be

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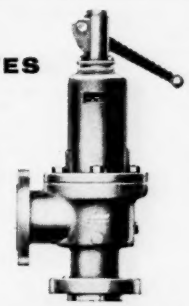

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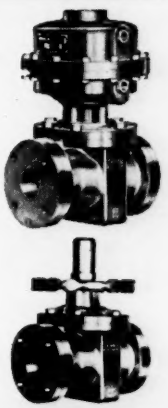
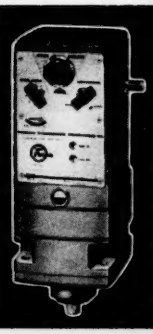
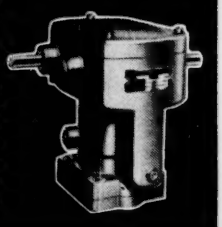


SPEED CONTROL



FARRIS-PICKERING GOVERNORS

The Type 3300 (left) and 4300 (right) Hydraulic Governors are the latest in this 100-year-old line of speed control devices . . . . Top performance, prompt, efficient repair service and the unique Farris Exchange Plan save time and money.



SEE FARRIS PRODUCTS ON DISPLAY — BOOTH 933
at the I. S. A. Show
Philadelphia, Pa., Sept. 15-19

PROGRESS THROUGH Farris HONEST PURPOSE

AFFILIATED COMPANIES
400 COMMERCIAL AVE., PALISADES PARK, N. J.

IN TEXAS:
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HOUSTON, 20

FARRIS ENGINEERING CORP. • FARRIS FLEXIBLE VALVE CORP. • FARRIS-PICKERING GOVERNOR CO., INC. • FARRIS HYDROSEAL CORP. • FARRIS HYDROTORQUE CORP.

For more information circle **10** on inquiry card.

throw away...

your pencils

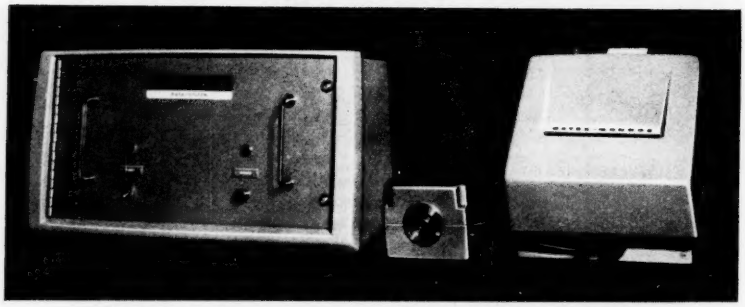
your log sheets

your strip charts

REDUCE COSTS
by using a...

DIGITAL RECORDING SYSTEM $1350

IMMEDIATE DELIVERY COMPLETE *



Eliminate Tedious and Erroneous Manual Logging of Recorder Readings... Transcribing Strip or Circular Chart Recordings

- Accuracy: ±0.1%
- Range: 000 to 999
- Speed: 2 readings/sec
- Complete with mounting hardware... ready to operate.

The DATEX K-120 Digital Recording System provides **fully automatic or on demand** digital recording on adding machine tape from self-balancing potentiometers, strip chart recorders, or shaft input. The K-120, consisting of hollow-shaft type shaft position-to-digital encoder, a control chassis, and a DATEX-MONROE printer*, is supplied as a ready-to-operate unit, complete with interconnections and hardware. Normal installation takes less than an hour.

Designed to operate with many types of recorders made by L & N, Bristol, and Honeywell... provides readout of position information from any shaft input. No gearing necessary between the encoder and instrument drive. The encoder will not affect the performance, response, or accuracy of the recorder. Over 100 encoder disc-patterns available. Translates shaft position up to 3 decimal digits (0-999), and provides a large number of non-linear calibrations for CuCn, I-C, and CrAl thermocouples.

*The K-120 utilizes the new DATEX-MONROE printer—first year's service and maintenance provided at no extra charge by your local Monroe office.

Write for full detailed information to...

A SUBSIDIARY OF G. M. GIANNINI & CO. INCORPORATED

DATEX CORPORATION

1307 S. MYRTLE AVENUE • MONROVIA, CALIFORNIA • ELLIOTT 9-5381

For more information circle **11** on inquiry card.

published shortly by the American Society for Testing Materials. Copies will be available directly from the Society.

The work done at the National Bureau of Standards is sponsored by the Bureau of Aeronautics; the Armour Research Foundation is working under contract to the Naval Air Material Center. Both of these programs are administered by Aeronautical Structures Laboratory and are in addition to the development work going on in our own laboratories. You may readily appreciate that the adaptation of the optical extensometers is but a small portion of our effort and accomplishment.

N. J. Kleiss, Captain, USN
Director,
Aeronautical Structures Laboratory
Philadelphia, Pa.

Reader Inquiries

Flame Velocity Apparatus

Professor of mechanical engineering seeks timing device for flame velocity apparatus being constructed for lab. Must measure time required for flame to travel between two fixed points. Ionization gaps or photoelectric cell are believed suitable. A-327

Conductivity Meter

Research librarian of industrial firm seeks conductivity meter measuring range of 0-500 grains sodium chloride per gallon. A-328

Portable X-Y Recorder

Consulting engineer is trying to find market for portable recorder with the following specifications: number of variables—6 (possible 12); signal—5mv dc or ac; maximum speed— 30 to 60 recordings per second; measurement cycle— 0.2 to 0.6 sec; recording surface— ordinary white paper; diagram frame 140 mm (time) x 60 mm (deflection); accuracy—0.2% of maximum deflection. A-329

Lighting System

Engineer seeks supplier of system that turns on lights when drive (twenty feet wide) would be entered. Actuation to be from infrared cell. A-330

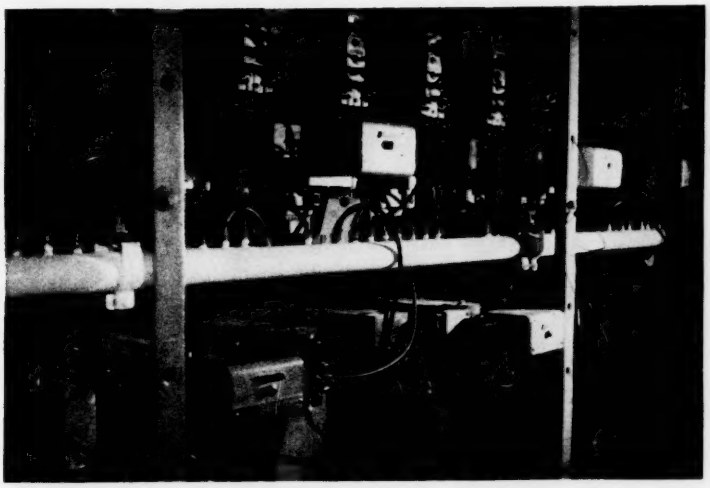
Colorimeter

Development engineer in large chemical company seeks color measuring instrument for yarn as it is being wound on take-up spool, without necessity of transfer to a color card and subsequent determination in measuring chamber. A-331

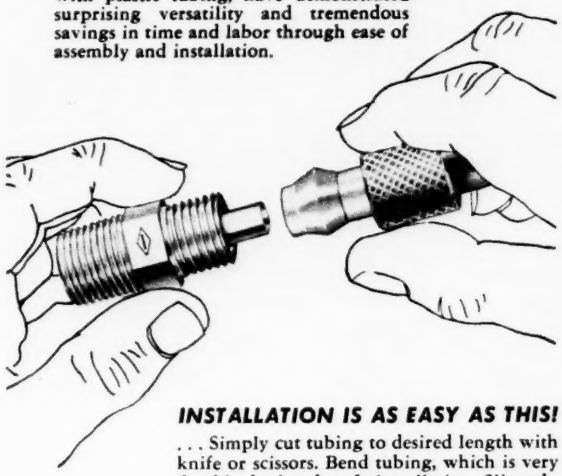
Chart Drive Hubs

Instrument manufacturer is interested in sources of supply for chart drive hubs and recorder linkages. A-332

INSTALLATION TIME and LABOR COSTS Reduced 93% by the use of IMPERIAL Poly-Flo FITTINGS and POLYETHYLENE TUBING



This instrument panel, in a large chemical plant, is one of a great many installations in which Imperial *Poly-Flo* Fittings, used with plastic tubing, have demonstrated surprising versatility and tremendous savings in time and labor through ease of assembly and installation.



INSTALLATION IS AS EASY AS THIS!

. . . Simply cut tubing to desired length with knife or scissors. Bend tubing, which is very flexible, by hand to fit installation. Slip tubing and reversible sleeve over tube support. Nut need only be finger tightened. A wrench is never necessary.

Ask for Bulletin No. 3025

Sensational savings in time and labor are typical of tubing installations made the *Imperial Poly-Flo Way*. Here is an actual documented example: on a chemical unit installation, labor cost of copper tubing was $2.10 per foot. On a similar installation, where polyethylene tubing and Imperial *Poly-Flo* Fittings were used, *the labor and cost was only 14½ cents per foot* — a saving of 93% in time and labor.

VERSATILITY . . . the field of application for this fabulous fitting is growing by leaps and bounds. The *Poly-Flo* has been enthusiastically accepted and widely adopted for use with polyethylene and other plastic tubing in instrumentation, chemical plants, refineries, metal working plants and paper mills, to mention a few.

FITTINGS AND TUBING furnished in 1/4", 5/16", 3/8" and 1/2" O.D. sizes. Tubing supplied in 9 colors — color coding quickly identifies circuits. Recommended for working pressures to 125 psi. — 1/4" O.D.; 160 psi. — 5/16" O.D.; 100 psi. — 3/8" O.D.; 75 psi. — 1/2" O.D. Temperatures from −90° F. to +175° F. Tubing is very tough and impervious to most chemicals.

ACCESSORIES include tube racks for mounting from 1 to 10 tubes; quick-disconnect and other shut-off valves; and convenient make-up kit of tubing and fittings.

THE IMPERIAL BRASS MFG. CO., 6300 W. Howard Street, Chicago 48, Illinois, Dept. IA88

In Canada: 18 Hook Avenue, Toronto, Ontario

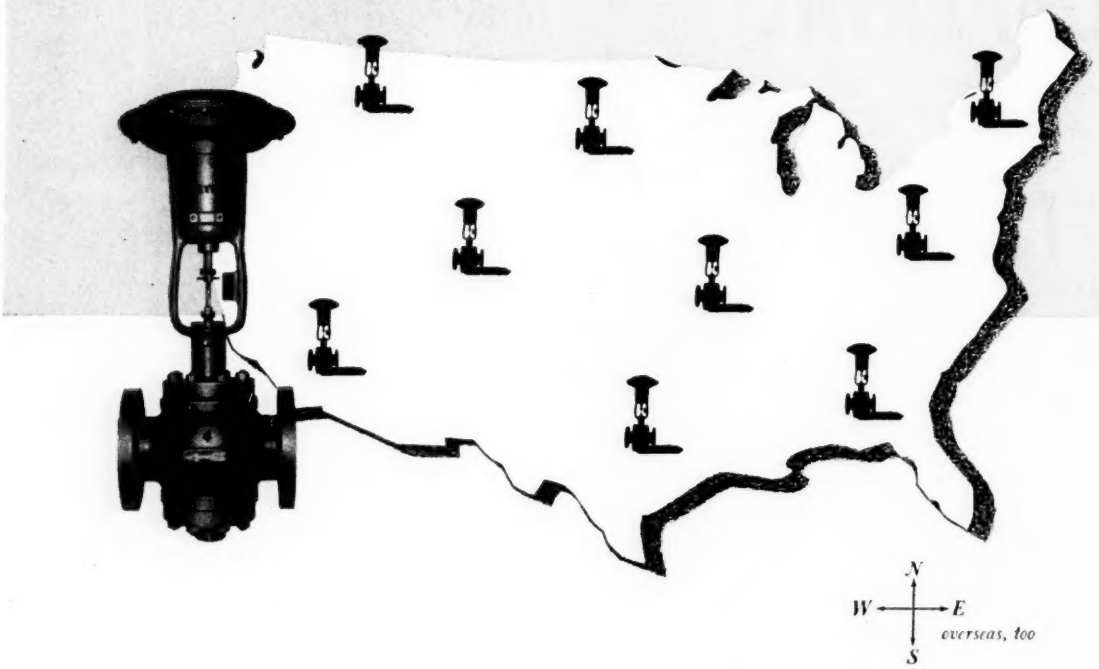
IMPERIAL

Emblem of Quality

Industry's Most Complete Line of Tube Fittings and Tubing Tools

For more information circle **12** on inquiry card.

where do you want your control valves?



Honeywell control valves are bought locally...serviced locally

Wherever you may be . . . there are Honeywell field engineers as near as your telephone . . . to sell and service *quality* control valves for your process needs.

Name the construction, material and size . . . Honeywell quality control valves are available in a wide range of types and sizes to meet your specific application requirements. From specification to startup, followed by periodic service . . . you're way ahead with Honeywell.

Next time you need control valves . . . why not do as others are doing . . . give your local Honeywell field engineer a call or write for literature.

MINNEAPOLIS-HONEYWELL, Fort Washington, Pa.

Honeywell

112 branch offices from coast to coast

H HONEYWELL *First in Control*

Business and Defense Services Administration of the U.S. Department of commerce reports "Rising laboratory and industrial instrument sales during the second half of 1958 are expected to equal the comparable period of 1957 for which a total of about $1.5 billion is indicated." Running counter to the downturn in expenditures for plant and equipment by business as a whole, this would be an increase of 12% above the $1.3 billion estimate for the first half of 1958. The Division said that rate of growth of the instrument industry will continue to run ahead of the rest of the economy.

> Laboratory and industrial instrument industry has been showing an average annual growth of approximately 15%, which is about five times that of the economy as a whole.

Analyzing capital expenditures by industry groups, BDSA reports that current figures indicate an increasingly larger share of the national investment is being devoted to improvement of facilities and less to expansion. Since control instruments offer improved manufacturing processes at reduced cost, this modernization program should stimulate instrument sales further.

> United States manufacturers of precision instruments used in chemical, nuclear, or physical studies have built an export business over the past three years that now approaches $250 million annually, reports the Scientific, Motion Picture, and Photographic Products Division, Business and Defense Services Administration, U. S. Department of Commerce. This trade, now reaching into more than a hundred countries, amounted to approximately $217 million in 1957, as compared with $164 million in 1956, and about $128 million in 1955, an increase of more than 70% in the period. Industrial and technical instruments represented three-fourths of the oversea market demand, of which the mechanical measuring type accounted for $134 million and the electrical, electronic group $30 million. The scientific, laboratory, engineering, and surveying category, though representing the remaining quarter of demand, nonetheless attained the greatest growth from $29 million to $52 million, an increase of 80% in 1957 over 1955.

Federal missile expenditures for fiscal 1959 are expected to reach $4.5 billion, compared to $2.5 billion in 1958. Electronic equipment appropriation requests for 1959 total $3.7 billion, including $1.1 billion for missile electronics, $1 billion for communications, $1.5 billion for aircraft electronics, $117 million for shipboard electronics.

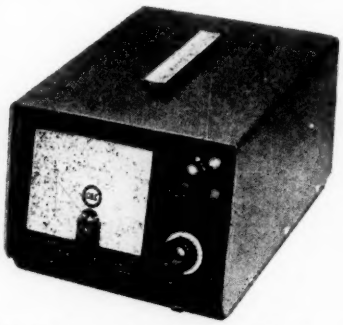
> There are now over 1,400 firms in Britain manufacturing and distributing over 2,700 kinds of electronic equipment. The industry employs over a quarter of a million people, whose annual output is valued at $840,000,000, reports book "British Communications & Electronics," Heywood & Co. Ltd., London.

CEC's new

extended-range moisture monitor

...fast, precise readings from 1 to 20,000 ppm

Type 26-302



$750.00 *complete*

Newest addition to CEC's line of moisture monitors, the 26-302 is the only precision instrument designed specifically to measure moisture in gases and gaseous mixtures over the range of from 1 to 20,000 ppm. Instrument features fast response with immediate recovery and is economically priced at $750.00.

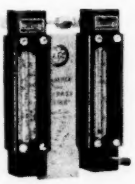
...and for the 0 to 1000 ppm range

CEC's low-cost 26-301

The industry-proven 26-301 gives precise readings from 0 to 1000 ppm, with 63% response to a step-function change in 30 seconds ... 95% response in one minute. Accuracy is guaranteed better than 5%. Complete instrument only **$650.00**

Both the 26-301 and new 26-302 are absolute measuring devices and do not require calibration. They can be equipped with a self-contained, plug-in battery pack for operation in areas where line power is not available.

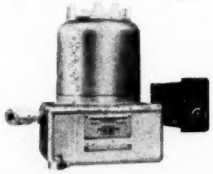
These accessories tailor basic models to custom needs ...



SAMPLE BY-PASS–CEC's 26-011 provides an indication of sample flow through the monitor and assures fast response of the external sample system. It consists of two flowmeters, one connected to the Sample-Out port to indicate flow and the other to purge the sample line.

SAMPLE VAPORIZER–CEC's 26-013 Sample Vaporizer is the newest accessory available for the 26-301 and 26-302. It enables the instruments to monitor moisture content of refrigerant gases or liquids and other gases or liquids having comparable characteristics.

For continuous in-plant measurement ... 26-310 **PROCESS MOISTURE MONITOR**



Consolidated's Process Moisture Monitor accurately measures extremely low concentrations of water vapor in process streams. The 26-310 assures precise regulation of sample flow under rugged process plant conditions, and is ideal for remote recording and control, even in hazardous locations.

WRITE FOR THESE BULLETINS

26-302 Extended-Range Moisture Monitor–Bulletin CEC 1849-X5.
26-301 Moisture Monitor–Bulletin CEC 1834-X30.
26-310 Process Moisture Monitor –Bulletin CEC 1845-X15.
26-011 Sample By-Pass and 26-013 Sample Vaporizer Accessories– Bulletin CEC 1848-X5.
... or contact your nearby CEC sales and service office.

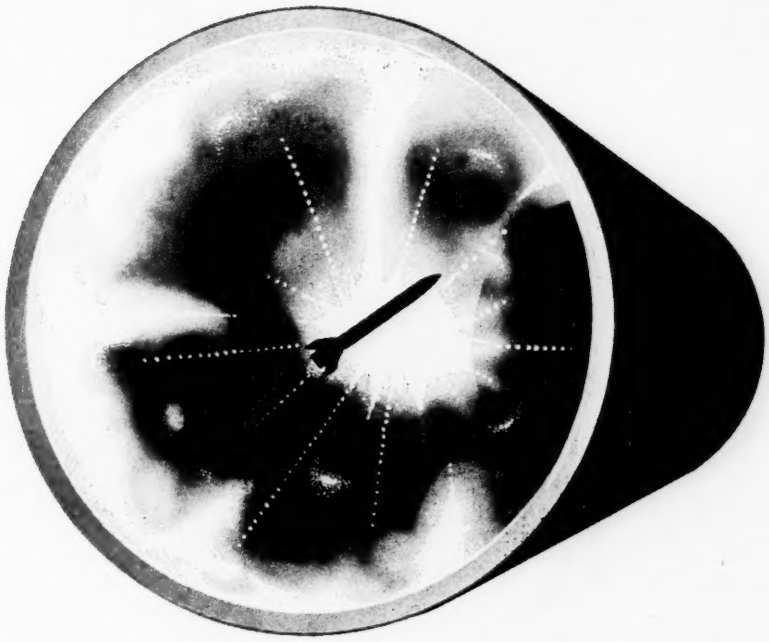
Analytical & Control Instrument Division

Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena, California

OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

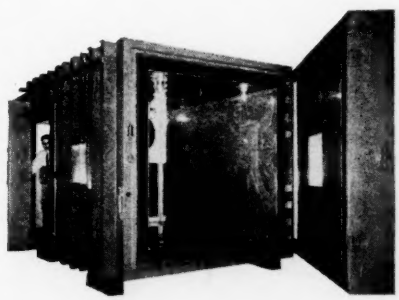
For more information circle **13** on inquiry card.



You name the environment ...TENNEY will simulate it!

Altitude, heat, cold, explosion, vacuum ... whatever environment you need, there is an extensively-tested Tenney prototype already built that is very near your specifications. By adjusting the prototype to fit your particular requirements, we can make delivery in a surprisingly short time. In operation, your Tenney chamber will reach ideal environmental conditions quickly, maintain them efficiently throughout the test run, and provide accurate data for quick, simple evaluation.

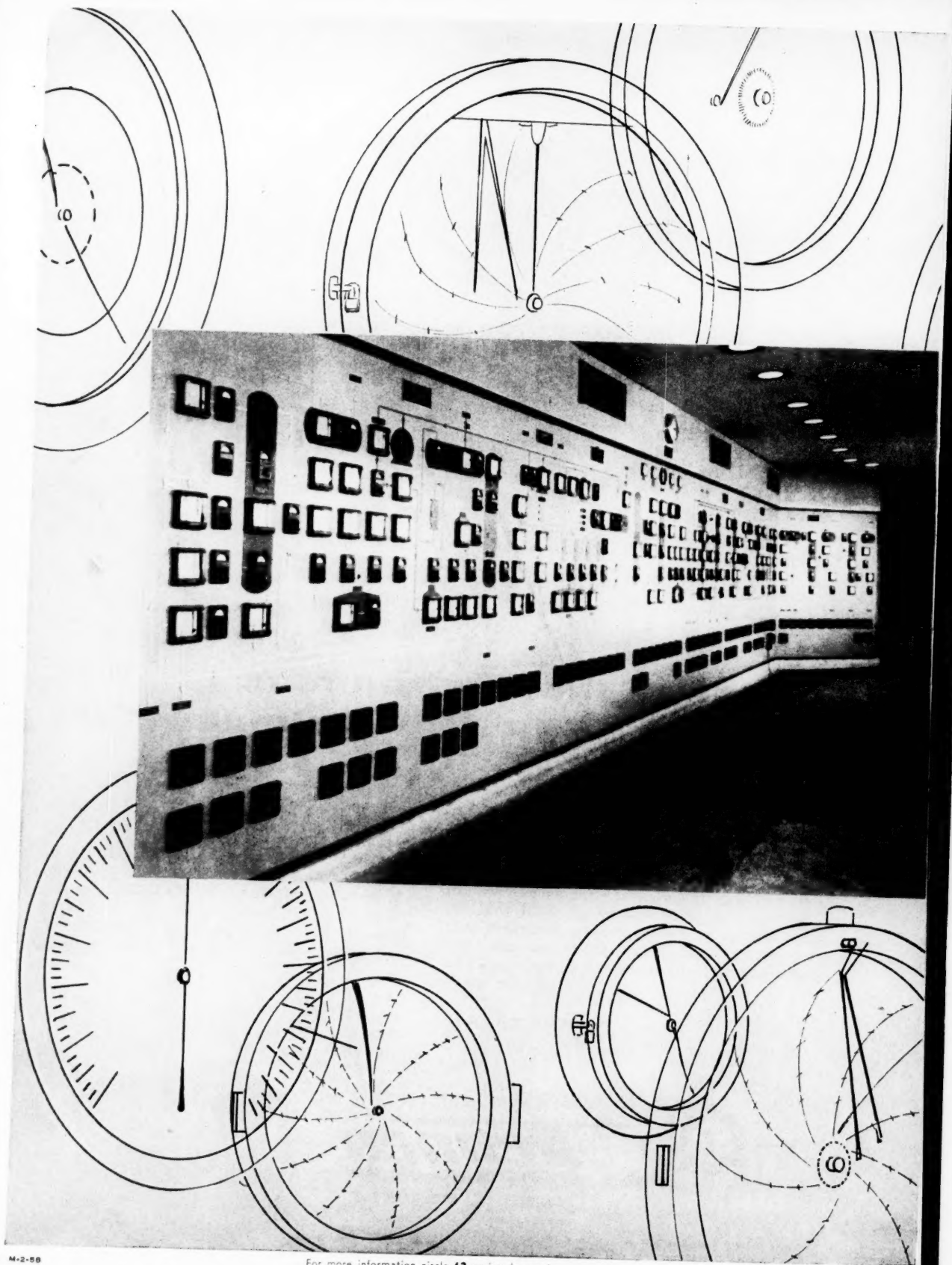
Tenney, pioneer in the science of environmental testing, is today the world's largest, most experienced creator of environmental testing equipment. Write today for literature describing Tenney's complete line of prototype chambers, or for information on Tenney's research and development, engineering consultation, and design services.



Tenney
ENGINEERING, INC.
1090 SPRINGFIELD ROAD, UNION, N. J.

PLANTS: UNION, N. J. AND BALTIMORE, MD. • THERE IS A TENNEY CHAMBER TO SIMULATE ALTITUDE, HEAT, COLD, HUMIDITY, VACUUM, EXPLOSION, SAND, DUST, FOG, AND MOST OTHER ENVIRONMENTAL CONDITIONS.

For more information circle **14** on inquiry card.



M-2-58

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AMERICAN-MICROSEN

FLEXIBILITY

anticipates ever-changing needs in process control

Some day your plant processes will include data handling or computing systems. Your processes will be changed to boost efficiency or to make new products for tomorrow's markets. You will use product stream analyzers.

Is your instrument system adaptable to keep pace with changes experience dictates in operating new processes?

The American-Microsen Electronic Process Control System is flexible. It is designed to solve ever-changing problems of process control. The DC signal used throughout is compatible with data handling systems. Changes in control arrangements are easy to make. Simply rewire instruments already on the job and plug in new components as needed. Standard instruments can be used for cascading, ratioing, programming, etc.

Flexibility is but one American-Microsen System advantage. Installation and operation are more economical. Accuracy is higher and control is closer whatever the distance between process and control room.

Try out the American-Microsen Process Control System. Write for information and ask one of our sales engineers to call. He will gladly explain how you can use the system profitably.

MANNING MAXWELL & MOORE INC. TRADE MARK

MANNING, MAXWELL & MOORE, INC.

INDUSTRIAL CONTROLS DIVISION • DANBURY, CONNECTICUT

MAKERS OF 'AMERICAN-MICROSEN' ELECTRONIC INSTRUMENTS FOR MEASUREMENT, TRANSMISSION AND CONTROL

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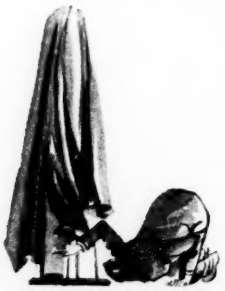
An Invitation From

FISHER

To Attend The International ISA Show

At Philadelphia
September 15-19, 1958

SEE ALL OF THESE NEW FISHER DEVELOPMENTS



The NEW 2500 lb. Bodies with Diaphragm Actuators

The NEW Electronic Level Transmitter

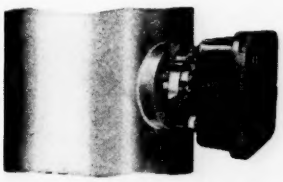
The NEW Powerful Piston-Type Actuator

The NEW Large Capacity Electro-Pneumatic Transducer

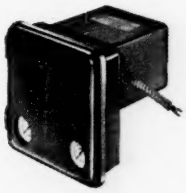
Visit the **FISHER-CONTINENTAL EXHIBIT**

BOOTH NUMBERS · 1138 · 1142 · 1239 · 1243

A NEW series of small diaphragm control valves with Bar Stock Bodies.



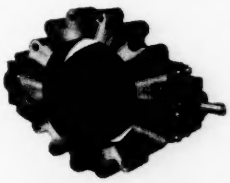
A NEW diaphragm type of Liquid Level Transmitter.



A NEW remote electrical drive unit "Kixcel" for remote control or telemetering

Plus

Continental Standard Pattern designed as a light weight, low cost valve suitable for a multitude of applications. Automatic or Manual Operation.



Available in seven classes of construction, the heavy pattern valve can handle pressure drops in excess of 500 psi, depending on size and operator.

Continental pressure sealed rubber seated valves for positive non-leak closure. Rubber neoprene or, metallic ring seal for various temperature, pressure and corrosive conditions.

If it flows through pipe anywhere in the world . . . chances are it's controlled by . . .

FISHER GOVERNOR COMPANY

Marshalltown, Iowa / Woodstock, Ontario / London, England

CONTINENTAL EQUIPMENT CO. DIVISION, Coraopolis, Pennsylvania

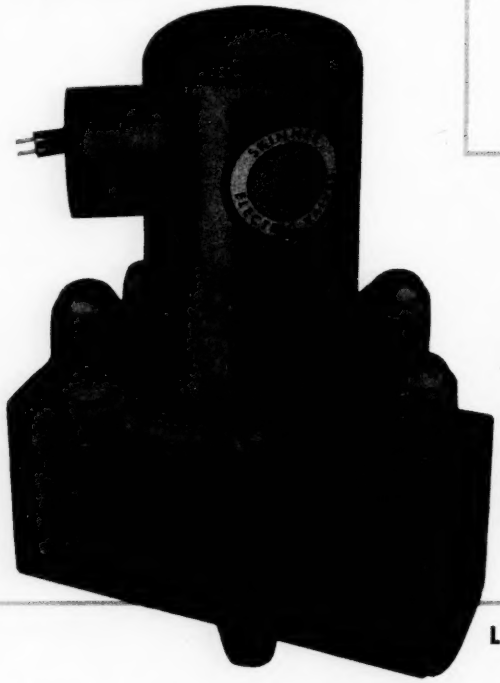
CONTINENTAL

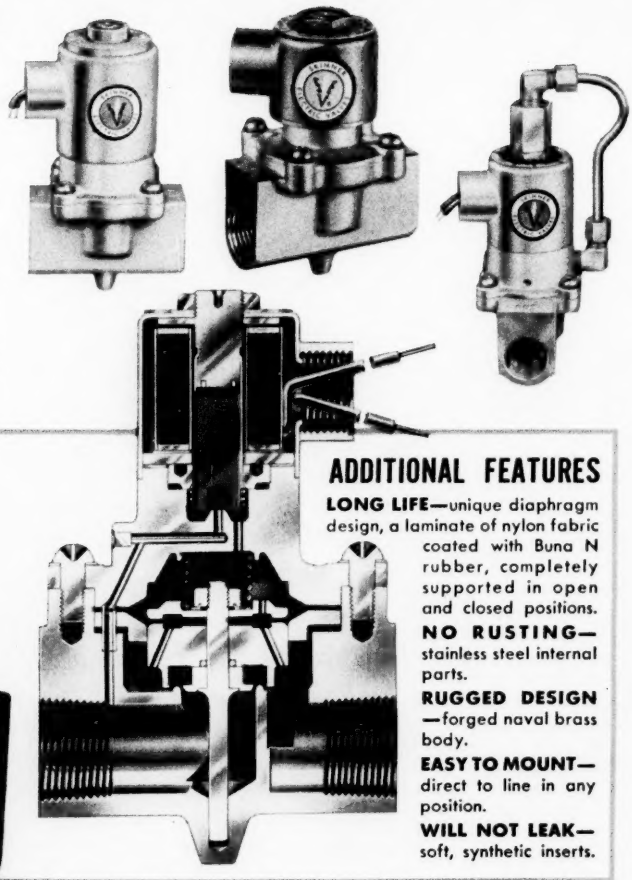
FISHER®

For more information circle **16** on inquiry card.

New low-cost, high-flow, 2-way valves with . . .

DEPENDABLE SKINNER QUALITY





ADDITIONAL FEATURES

LONG LIFE—unique diaphragm design, a laminate of nylon fabric coated with Buna N rubber, completely supported in open and closed positions.

NO RUSTING—stainless steel internal parts.

RUGGED DESIGN—forged naval brass body.

EASY TO MOUNT—direct to line in any position.

WILL NOT LEAK—soft, synthetic inserts.

L SERIES

These L Series valves with ¾″ and 1″ diameter orifices complete an *all new* line of 2-way valves previously introduced in January in the ⅜″ and ½″ sizes.

Manufactured to the highest engineering standards, these pilot-operated, high-flow industrial valves are a welcome addition to the famous Skinner solenoid valve line. They are smaller and more compact than the M2 Series they replace and feature a unique diaphragm design. They are also considerably lower in cost. The ¾″ size, for example, will cost you 51% less.

These larger L Series models – ¾″ and 1″ – will be available in standard and Explosion-proof construction, normally open or normally closed. They operate on a pressure differential of 5 to 150 psi and will control such common media as air, oil and water.

For complete information, please contact our Representative or Distributor near you . . . you'll find him listed in the yellow pages or write us at the address below, Department 418.

SKINNER ELECTRIC VALVES

THE CREST OF QUALITY

SKINNER ELECTRIC VALVE DIVISION

NEW BRITAIN CONNECTICUT

105 EDGEWOOD AVENUE

For more information circle **17** on inquiry card.

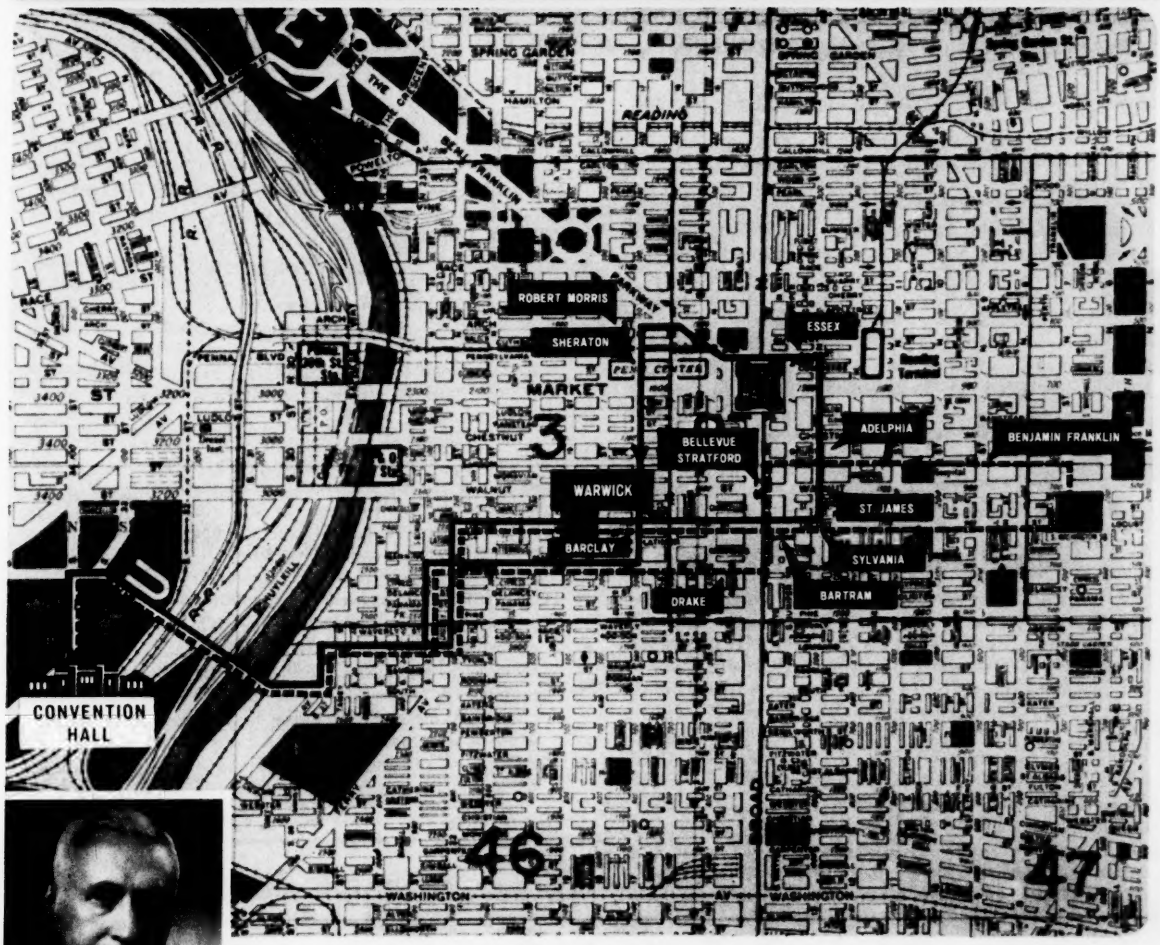
Again this year...

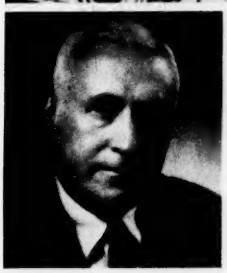
free Swagelok® Shuttle Bus Service

during the ISA Conference and Exhibit • September 15-19, 1958

in the "City of Brotherly Love"

During conference and exhibit hours, free Swagelok Busses will run every twenty minutes between the Philadelphia Convention Hall and downtown hotels. See the placard in your hotel lobby for schedules and boarding locations.





We are happy to make the Swagelok Shuttle Busses available again this year and hope that you will find this service a convenience during your stay in Philadelphia.

Fred A. Lennon President, Crawford Fitting Company

CRAWFORD FITTING COMPANY · 884 EAST 140TH STREET, CLEVELAND 10, OHIO

For more information circle **18** on inquiry card.

news

Gordon Research Conference

NEW LONDON, N. H.—The Conference on Instrumentation in the yearly series of Gordon Research Conferences was held July 28 through August 1st at Colby

Junior College with N. B. Nichols, vice president of Taylor Instrument Cos. as chairman. About 90 people participated, mostly from the research departments of industrial firms and universities. The first Conference on Instrumentation was organized in 1942 by Richard Rimbach, Publisher of *I&A*, and held at Gibson Island. The conferences were established to stimulate research in universities, research foundations, and industrial laboratories. Informal meetings are held consisting of scheduled lectures and free discussion groups. This year's lectures comprised eight invited and sixteen contributed papers. Conference rules stipulate that no publications be prepared as emanating from the Conference. Dr. Clifford E. Berry, assistant director of research, Consolidated Electrodynamics Corp. was elected chairman of the Conference on Instrumentation for 1959.

ISA Conference and Exhibit

PITTSBURGH, PA.—The thirteenth annual Instrument-Automation Conference and Exhibit (International) will be held at Philadelphia's Convention Hall Monday through Friday September 14 through 19, 1958. The program includes (1) Technical Sessions for Monday through Thursday (registration fee including preprints $8.00 for ISA, ASME, AIEE, ACM and IRE members, $12.00 for non-members); (2) an Instrumentation Clinic on Sunday, and Monday (at the University of Pennsylvania; registration fee $5.00 for members and $8.00 for non-members); and (3) a series of five Workshops Sunday through Wednesday (in the Hotel Sheraton and Convention Hall; included in fee for Technical Sessions). Besides a one-day Computer Clinic on Thursday (included in Technical Sessions registration fee); a series of three lectures of a tutorial survey type; plant tours; and a ladies' program have been organized.

Flood Affects You

PONTIAC, ILL.—The Vermillion river crested at 100 inches over the Mill Street dam at 8 P. M. Tuesday July 15. The damage of $50.000 to Morton Printing Company included your July and August issues of *I&A*, which is why you received them a bit late.

German Automation Study Team Confers with Staff of *I&A*

PITTSBURGH, PA.—An eight-man automation study team from Western Germany which toured the country under the sponsorship of the International Cooperation Administration visited Instruments Publishing Company July 3rd. The team included Messrs. Marcel A. Axmann, engineer for Askania Werke; Alfred H. Fleischmann, chief engineer for Schleicher Relaisbau; Walter M. Fromm, chief engineer for Zeiss Ikon; Otto A. Gilg, mechanic for Osram; Reinhard Lange, chemist for Dr. B. Lange; Joachim Richter, manager of P. Gossen & Co.; Wilhelm H. Riemer, foreman of Allgemeine Elektrizitaets Gesellschaft; and Kurt R. Schoener, chief engineer for Ludwig Loewe & Co.

Electrical Measuring Instrument Production For Period July 1, 1956 to June 30, 1957

WASHINGTON, D. C.—The accompanying tabulation represents the first stage of a production survey on Electrical Measuring Instruments being conducted by the Scientific, Motion Picture and Photographic Products Division, Business and Defense Services Administration, of the U. S. Department of Commerce.

This survey is one of six phases of a comprehensive statistical reporting program for the scientific and industrial instrument field, designed to provide the proper product and market identification essential to conducting a meaningful market analysis, as well as definitions and classifications which recognize the dynamic transformation undergone by the instrument field. Other phases of the over-all program include optical, gyroscopic, filled-system, differential expansion and similar non-electrical instruments, nuclear radiation instruments; to be followed by a survey of packaged instruments and instrument systems. In addition to the electrical instrument phase, a survey on optical instruments has already been completed by the Division.

The data contained in the tabulation are expressed in terms of *Basic Instrument Units*, defined as follows:

A Basic Instrument Unit is an assembly of parts necessary to form a self-contained unit for performing a measuring, controlling or recording operation. A basic unit may be either used as a complete measuring device in itself, or incorporated as a component of a packaged instrument or instrument system, which may contain two or more different functional groupings.

Continued on page 1296

Clayton W. Work

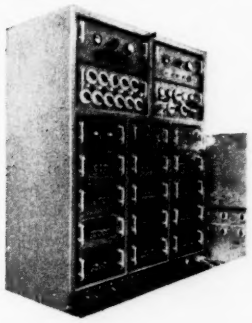
Clayton W. Work, sales promotion manager for the instruments and controls division of Hagan Chemicals & Controls, Inc., died suddenly June 19 while attending a class reunion in Exeter, N. H. Mr. Work, who was to retire this year after 34 years with Hagan, served as a specialist in the installation, adjustment and repair of combustion control equipment, as coordinator for engineering, sales and estimating, and as director of the company's annual sales conferences. He is survived by his wife Elizabeth, a daughter, son and four grandchildren.

Here's how General Electric solves typical DC power-supply problems

for computers and special applications

PROBLEM

"We need to devote our engineering time to designing our electronic circuitry . . . not the power components."



SOLUTION

This is a frequent problem facing computer manufacturers. General Electric's Rectifier Department has complete engineering and manufacturing capability not only to design and apply all types of power supplies, but also to incorporate power supplies into completely integrated systems.

These systems could include load distribution, supply sequencing, protection for power supply and load, and complete power distribution. Let General Electric tackle your DC power problems such as those associated with load IR drop, "cross talk," and other nuisance-type problems plaguing your engineers.

PROBLEM

"It's always a problem making sure transistorized equipment is safe from its power supply."

SOLUTION

To alleviate this problem, General Electric has developed several methods of making transistorized equipment safer in this respect. With G-E protective circuits, shorting a plus high-voltage bus to a plus or minus low-voltage bus would not cause the low-voltage bus to exceed a small percentage of nominal rated value.

General Electric power supplies protect completely transistorized pieces of equipment from large losses due to over-voltage failures.

PROBLEM

"My power supply requirements fluctuate so much . . . big jobs. little jobs, all in between."

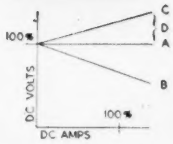
SOLUTION

G.E. has built individual power supplies and complete systems ranging from less than one watt up to 35,000 kilowatts. These power supplies span the complete range of DC power—regulated and unregulated—applying all types of components. G-E experience includes completely transistorized supplies, and supplies with the new controlled rectifier, magnetic amplifiers, voltage stabilizing transformers, and motor-alternator "brute force" systems.

PROBLEM

"We have a real low-voltage power distribution problem with our computer."

SOLUTION



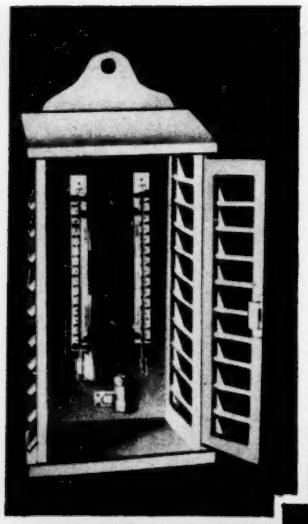
Low-voltage distribution problems can be handled easily through load compensation. Curve "A" is net desired no-load to full-load regulation at load point. "B" is regulation at load without remote sensing or load compensation. "C" represents IR compensation in power supply itself. "D" is amount of IR or load compensation.

If you have a computer or special power-supply problem, free your engineers of this problem and turn it over to General Electric for solution. It's more economical! G-E engineers can call on over 40 years of experience in the metallic rectifier field and put this experience to work in solving your particular problem—large or small. Contact your nearest General Electric Apparatus Sales Office or write Section F465-6, Rectifier Department, General Electric Company, Lynchburg, Virginia.

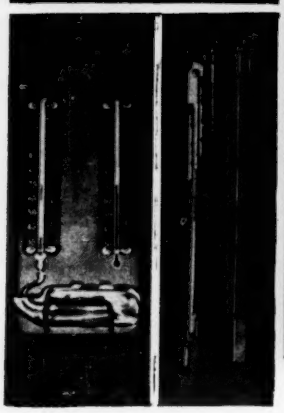
Progress Is Our Most Important Product

GENERAL ELECTRIC

For more information circle **19** on inquiry card.



You get dependability PLUS with Moeller psychrometers



because designing and manufacturing temperature measuring instruments and psychrometers has been our business since 1867.

Nothing's as changeable as the weather and the atmosphere unless it's the reading indicated on Moeller Psychrometers. For almost 90 years—whether indoors or out—Moeller Psychrometers have proven accurate, regardless of climatic conditions.

Send for descriptive literature, today!

MOELLER INSTRUMENT COMPANY
132nd ST. and 89th AVE.
RICHMOND HILL 18, N. Y.
Representatives in Principal Cities

Gentlemen: Without obligation, please send me Catalog No. 150 on Moeller Psychrometers.

NAME .....

FIRM .....

ADDRESS .....

CITY ..... ZONE ..... STATE .....

For more information circle **20** on inquiry card.

NEWS—CONTINUED

The complete study, which will embrace a detailed description of the comprehensive statistical program, as well as the analysis and interpretation of the results of the Electrical Measuring Instrument Survey in relation to the program, is in the process of preparation by the Scientific, Motion Picture and Photographic Products Division and will be ready for release later in the year. An announcement will be made as soon as the completed study is ready for distribution.

RECAPITULATION OF ELECTRICAL MEASURING INSTRUMENT PRODUCTION
Period Covered: July 1, 1956 to June 30, 1957

Type	Quantity (units)
Regular Panel Instruments	1,667,678
Ruggedized Panel Instruments	387,509
Switchboard Instruments, Regular	136,875
Switchboard Instruments, High Shock	12,888
Direct Reflecting Recording & Controlling Instruments	99,050
Self Balancing Indicating, Recording & Controlling Instruments	46,304
Aircraft Instruments	161,259
Portables	21,878
Small Portables	32,178
Miniature Portables	72,849
Portable Standards	14,670
Laboratory Standards	1,711
Instrument Relays and Contact Making Instruments	99,357
Miscellaneous Instruments, Not Listed Above	24,065
Total	2,778,271

News Bits

Fred A. Lennon, president of **CRAWFORD FITTING CO.,** will again furnish free shuttle bus service from the downtown hotels to Convention Hall in Philadelphia. ISA Show visitors have become used to looking for the familiar Swagelok buses since they were first operated in Cleveland in 1952. (Full information on schedules appears on page 1293).

PHILCO CORP. and LEEDS & NORTHRUP CO. have announced a joint computer program to develop, design and build a digital computer specifically for applications in industrial process control, and in scientific and engineering computation, including data processing.

J. W. FECKER, INC., a subsidiary of American Optical Company, under contract with the U. S. Air Force, is designing the world's largest solar furnace to be erected soon near Cloudcroft, New Mexico.

INTERNATIONAL PHYSICAL INDEX, Inc., 1909 Park Ave., New York 35, N. Y. announces a series of scientific periodicals based on translations from sixty-seven current Russian technical periodicals and transactions: (1) *Electronics Express*—$57.50 per year (10 issues of 40 pages each per year); (2) *Automation Express*—$57.50 per year (10 issues of 40 pages each per year); (3) *Physics Express*—$57.50 per year (10 issues of 40 pages each year). Any two Expresses—$100.00 per year.

MID-CENTURY INSTRUMATIC CORPORATION of New York City, analog computer manufacturers, has introduced a fresh marketing concept as part of highly concentrated expansion program—*lease-type rentals* plus *trade-in allowance* on existing analog computer equipments or systems that are too small or out of date.

ELECTRONIC ENGINEERING CO. unveiled its computer language translator at the recent Western Joint Computer Conference. It performs such tasks as conversions from Teletype paper tape to magnetic tape, or from one magnetic tape format to a different one.

Circle **21** on inquiry card. ⟶

Some of the 150 Foxboro Dynalog Recorders used at Rocketdyne's Propulsion Field Laboratory. During each test, these instruments log critical items of information with split-second timing and exacting accuracy.

where accurate, dependable records are a MUST

ROCKETDYNE looks to DYNALOG* Electronic Recorders

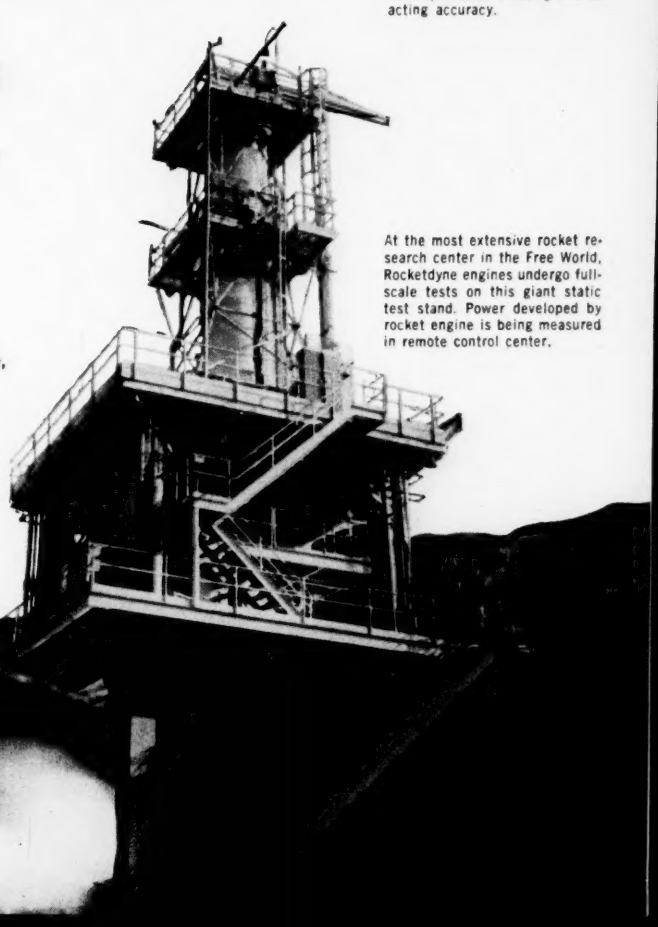
Test-firing is a vital function at Rocketdyne, a division of North American Aviation, Inc. Rocketdyne manufactures liquid propellant rocket engines for the Army's Redstone and Jupiter missiles; the Air Force Atlas and Thor.

Critical data on engine thrust, temperature, valve operation, and many other performance characteristics are recorded by a remote battery of 150 Dynalog Electronic Recorders.

Dynalogs fit Rocketdyne's instrument requirements to a T: accurate within $\pm\frac{1}{4}\%$ of full scale, one second pen sweep, high input impedance. And because Dynalogs have no slidewire, Rocketdyne finds their maintenance problems practically eliminated. They prefer circular charts also, for faster, easier analysis of each measured variable after a test firing.

Rocketdyne is presently using over 1,000 Dynalog Recorders. Find out how Dynalog Instruments can improve recording and control of your process. Write for Bulletin 20-10.
The Foxboro Company, 468 Neponset Ave., Foxboro, Mass.

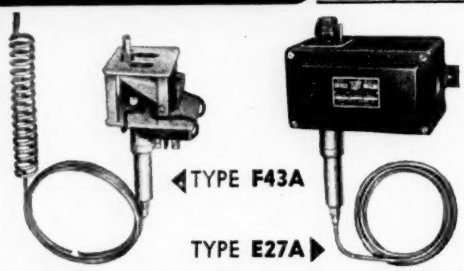
*Reg. U. S. Pat. Off.



At the most extensive rocket research center in the Free World, Rocketdyne engines undergo full-scale tests on this giant static test stand. Power developed by rocket engine is being measured in remote control center.

FOXBORO
REG. U.S. PAT. OFF.

Dual Switch
REMOTE BULB
TEMPERATURE CONTROLS **F43A | E27A**



The F43A and E27A are functionally similar units that are offered by UNITED ELECTRIC for applications where it is desirable to control two separate circuits at different temperatures by means of a single temperature control. The major differences between the two units are that the F43A is an uncalibrated, wide range, skeleton unit while the E27A is calibrated, has a narrow range, and is enclosed. If desired, the E27A can be modified to have a wide range.

Temperature Ranges . . .	F43A — up to maximum limits of −150° to +150°F., 70° to 370°F., or 100° to 650°F. E27A — 100° or 200°F. spans between −150° and +650°F. limits.
On-Off Differential	Approximately 1.0°F. or 2.0°F. depending upon the model.
Switch Ratings	Up to 15 amps. at 115 or 230 volts A.C. 20 amps. A.C. or D.C. switches also available.
Switch Types	N.O., N.C., or Double Throw — no neutral position.
Adjustments.	F43A — slotted range adjustment screw on top, uncalibrated settings. E27A — external knob and pointer, calibrated settings. In each unit, switch may be adjusted individually to provide for approximately 15°F. max. span between switch settings. Span remains constant over entire range.
Electrical Connections . .	Via attached terminal blocks.
Capillary Tube Length . .	6-foot standard length. Other lengths available.
Mounting	F43A — via tapped holes in top plate. E27A — via mounting ears or tapped holes.

UNITED ELECTRIC *manufactures a complete line of temperature, pressure and vacuum controls. For special applications, standard units may be modified, or custom-built units may be provided. For additional data on remote type temperature controls, including types F43A and E27A, request* Section 200 *of our new catalog.*

U.E. United Electric Controls COMPANY
91 SCHOOL STREET, WATERTOWN, MASS.

For more information circle **22** on inquiry card.

stock report

Any further information concerning any of the following issues may be obtained from the Research Department, Bache & Co., 36 Wall Street, New York 5, N. Y.

American Stock Exchange:

AMERICAN STOCK EXCHANGE
Price Range For 1958 Thru 7/16/58

	HIGH	LOW	Price As of 7/16/58
American Meter	35 1/2	27 5/8	34 3/4
Arv Equipment	18 1/2	13 3/4	16 1/2
Barry Controls "B"	8 1/2	4 3/8	7 - 7 3/4 (1)
Bridge Instruments	10 1/8	7 3/8	10 1/4
Bruns Watch	6 7/8	4 7/8	5
Breese Corp.	6 1/2	5 1/8	5 3/8
Clark Controller	17 7/8	14 7/8	16 3/8
Clarostat Mfg.	5 3/4	2 7/8	5 1/4
Clary Corp.	4 3/4	2 7/8	3 7/8 - 4 (1)
DuMont Laboratories	5 5/8	3	4 5/8
Dynamics Corp. of America	4 1/8	2 7/8	3 5/8
Electronics Corp. of America	7 1/8	6 3/8	7
El-Tronics	2 1/8	1 5/8	1 7/8
Fairchild Camera & Instrument	31 7/8	19 1/2	25
Globe-Union	17 1/4	14 5/8	15 5/8 - 16 (1)
Hazeltine Corp.	42	30 1/2	39 1/2
International Resistance	4 5/8	3 3/4	4
Lear, Inc.	7 1/8	4 1/4	6 5/8
National Research	16 3/4	12 7/8	14 5/8
Neptune Meter	26	19 1/2	25 3/4
New Haven Clock	3 1/4	7/8	1 3/8 - 1 1/2 (1)
Norden-Ketay	6 7/8	2 3/4	5
Nuclear Corp. of America	3 1/2	1 1/8	1 1/4
Pneumatic Scale	36	18 1/2	30 1/4 - 31 1/2 (1)
Servo Corp. of America	6 1/4	3 3/4	5 7/8
Servomechanisms	11 1/8	6 5/8	10 1/2
Wallace & Tiernan	27 1/4	24	24 5/8 - 25 1/4 (1)
Waltham Prec. Instrument Co.	1 1/2	13/16	1/8

1) Not Traded, Bid and Asked

New York Stock Exchange:

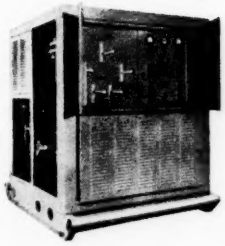
NEW YORK STOCK EXCHANGE
Price Range For 1958 Thru 7/16/58

	HIGH	LOW	Price As of 7/16/58
ACF Industries	20 1/4	17 1/8	18 1/8
Aeroquip Corp.	21 7/8	16 7/8	18 1/8
Allis Chalmers	26 1/4	22 1/8	25 1/4
American Chain & Cable	45 1/4	39 1/2	44
American Machine & Foundry	37 7/8	32 1/4	36 1/4
American Machine & Metals	57 1/2	44 1/2	54
American Optical	39 1/8	36	36 1/4
American Tel. & Tel.	179 1/2	167 7/8	178 3/8
Beckman Instruments	25 1/4	18 1/8	19 7/8
Bell & Howell	65 1/8	42	62
Bendix Aviation	56 1/2	44 1/2	56 1/4
Boeing Airplane	46 1/4	34 1/8	43 1/8
Bullard	15 3/4	10	13 5/8
Bulova Watch	12 5/8	9 3/4	11 1/2
Burroughs	36 1/8	27 5/8	32 1/2
Carborundum	35 7/8	30 7/8	32
Cincinnati Milling Machine	27	21	23 3/4
Clevite	18 3/8	15 3/4	17 1/4
Columbia Broadcasting "A"	32	24 1/2	30 1/8
Consolidated Electrodynamics	35 1/4	27 7/8	30
Consolidated Electronics	26 3/4	19 1/2	23 3/8 - 24 (1)
Cornel Dubilier	17 1/4	12 3/4	16 5/8
Corning Glass	86 1/4	74 3/8	84 1/2
Curtiss-Wright	26 1/8	20 3/8	24 3/4
Cutler Hammer	52 5/8	40 1/2	51 1/2
Daystron	16 1/2	10	14 1/4
Douglas Aircraft	74 7/8	54 1/2	57 1/2
Eastman Kodak	113 3/4	93 1/8	112 1/2
Eaton Manufacturing	47 1/2	38 1/2	47 3/8
Electric Auto Lite	32 1/8	25	31 1/4
Elgin Watch	9 3/4	6 3/4	7 3/4
Emerson Electric	40 1/4	29	36 1/4
Food Machinery & Chemical	57 3/8	43 1/2	56 1/2
Genevell	29 1/2	20 1/2	29 1/4
Gerrett	43 3/8	27	42 1/8
General Dynamics	65 1/4	45	58
General Electric	64 1/4	51	60 1/8
General Instrument	9 1/8	4 5/8	8 3/4
General Mills	80 1/4	60 1/4	78 1/2
General Precision Equipment	41 1/4	28 1/2	31 1/4
General Railway Signal	29 1/8	22 1/8	28 3/4
General Telephone	31 1/4	24 3/8	30 7/8
General Time	26 1/2	19 5/8	24 1/4
General Tire & Rubber	30	23 1/4	23 3/4
International Bus. Machines	713	530	699 1/2
International Tel. & Tel.	33 1/8	29 1/4	32 1/8
ITE Circuit Breaker	41 1/2	36 1/8	38 1/8
Litton Industries	53	36 7/8	48
Lockheed Aircraft	50 1/8	38 3/8	49 1/2
Magnavox	38 3/4	30 1/4	38 1/2
Mallory	28 1/4	23 5/8	25 3/4
Minneapolis-Honeywell	92 1/4	76	90 3/4
Minneapolis-Mining & Mfg.	85	73 1/2	82 5/8
Motorola	42 1/4	35	39
National Acme	53 1/2	43 7/8	47 7/8
National Cash Register	71 1/2	50 1/2	65 1/4
North American Aviation	33 5/8	25 5/8	32 1/8
Northrop Aircraft	25 1/4	22 1/8	25 1/8
Otis Elevator	50	40 1/4	50 3/4

Continued on page 1301

When the target is space and a million dollars' worth of missile rests idly on the ground—not even a long countdown helps. In a showdown situation, the successful shoot depends on the "go, no-go" type of test that pinpoints the trouble.

NEXT TIME...LOOK TO INET FOR PRECISE GROUND POWER



This INET 400-cycle ground power unit was tailor-made for the Atlas. In meeting all of Convair's specifications for pre-flight calibration of electrical systems, the unit operates in parallel with the missile's power system and provides remote control regulation. Frequency regulation is ±0.2%. With shock load equal to a third of rated output, frequency recovers to ±0.2% in 0.15 seconds. Voltage regulation is ±0.5% with recovery time at 0.30 seconds.

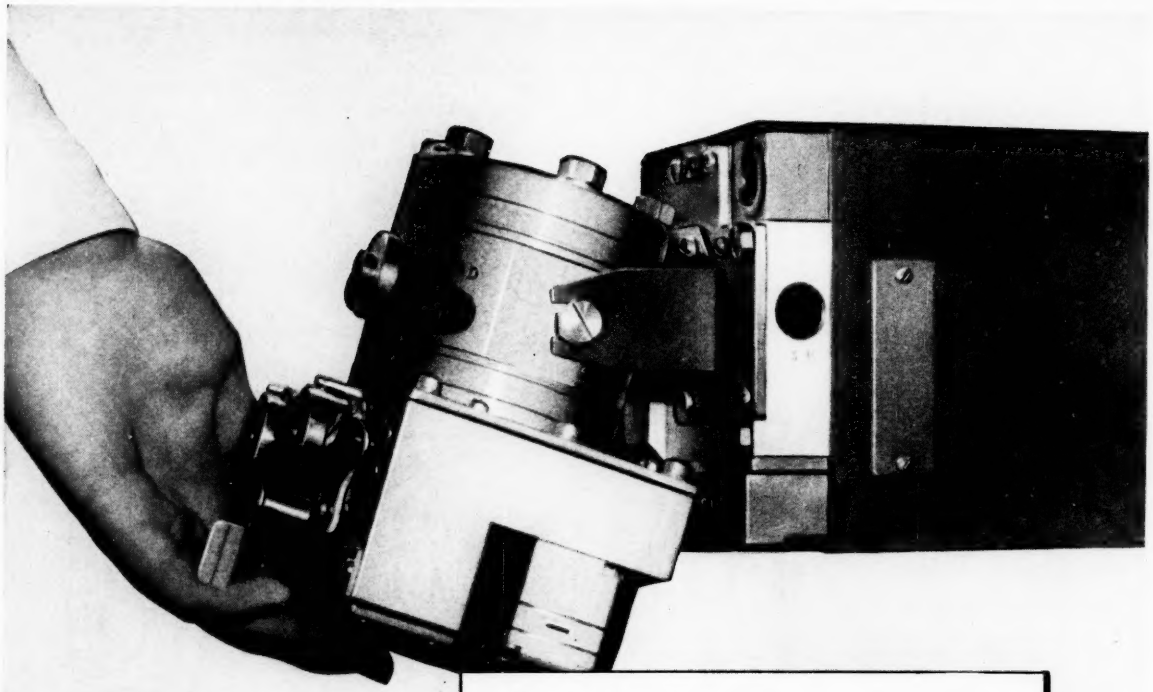
Missile men desiring a special reprint of the above cartoon should write to "Count-down", c/o Inet Division of Leach.

INET DIVISION LEACH CORPORATION

18435 SUSANA ROAD, COMPTON, CALIFORNIA

DISTRICT OFFICES AND REPRESENTATIVES IN PRINCIPAL CITIES OF U. S. AND CANADA

For more information circle **23** on inquiry card.



You save in many ways with TEL-O-SET controllers...

... today's most advanced pneumatic controllers

Control any process variable with a simple yet highly sensitive *Tel-O-Set* controller. Get all the high-performance characteristics you expect from a modern controller . . . plus specific savings.

CUT INSTALLATION COSTS

- Quick-connect assembly makes controller mounting easy.
- Mounting manifold preserves quick-connect and bumpless transfer features.

CUT SPARE PARTS INVENTORY

- Only one basic controller needed for all applications.
- Add rate action easily for more complex processes.

REDUCE PROCESS DOWNTIME

- Process remains on manual control when controller is removed.
- Unique design eliminates start-up overshoot.

SAVE MAINTENANCE

- Foolproof reassembly after cleaning and servicing.
- Repairs easily made by any maintenance man.

Get complete details on controllers and other *Tel-O-Set* instruments from your nearby Honeywell field engineer. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

First in Controls

New York Stock Exchange: *Continued from page 1298*

Philco Corp.	1[1] 7/8	12 3/8	16 5/8
Radio Corp. of America	34 1/8	30 1/4	35
Raytheon	33 1/2	28 1/8	32 1/8
Reliance Electric	14 1/8	12	16
Rheem Mfg.	14 3/4	10 1/2	12 1/8
Robertshaw-Fulton	24 3/4	22 1/4	25 5/8
Royal McBee	21	16	18 1/4
Sangamo Electric	25	25	26
Sperry Rand	20 5/8	17 1/4	18 1/8
Square D	24 3/8	20 1/8	21 3/8
Standard Coil Products	6 1/8	5	5 3/4
Starrett (L.S.)	4 3/4	5	10
Stewart-Warner	16 1/8	29	32 1/8
Sylvania Electric	37 1/4	31 1/2	36 1/4
Teleautograph	7/8	1 3/4	2 1/8
Texas Instruments	42 3/4	28 3/4	41 1/8
Thompson Products	35 1/4	41 3/8	52 1/2
Time-Dox Electric	26	21 1/4	26 1/8 - e[1] [1]
Underwood Corp.	22	23 7/8	27 3/8
Union Carbide Corp.	96	83 7/8	92
United Shoe Machinery	47 1/2	42	44
Western Union	20 7/8	15	20 1/8
Westinghouse Air Brake	24 1/2	21 7/8	22 1/4
Westinghouse Electric	60 1/2	50 1/2	54 1/8
Worthington Corp.	39 1/4	28 1/4	39

1) Not Traded - Bid and Asked

Over-The-Counter

OVER-THE-COUNTER

Quotation as of 7/16/58

	Bid	Asked
Aerovox Corp.	4 1/4	4 5/8
Aircraft Radio Corp.	19 1/2	20 3/4
Argus Corp.	22 1/2	23 3/4
Eitel-McCullough	27 1/2	28 1/2
Electronics Associates	38	39 1/4
Erie Resistor Corp.	6 3/8	7
Fisher Governor Company	13 1/2	14 1/4
G.M.Giannini	12 1/2	13 3/8
Industro Transistor	2	2 3/8
Liquidometer Corp.	5 1/2	6 1/8
W.L.Maxson	5 1/8	5 3/4
Penn Controls, Inc.	14 1/2	15
Speer Carbon, Inc.	24 1/4	25 3/4
Sprague Electric	32	34
Taylor Instrument	26 1/4	27 1/2
Telecomputing Corp.	4 1/8	4 5/8
Topp Industries	8 3/4	9 1/4
Varian Associates	21 7/8	22 1/2
Vitro Corp. of America	14 5/8	15 3/8

MARSHALLTOWN

DIAPHRAGM GAUGE FOR ACCURATE PRESSURE MEASUREMENT IN OUNCES OR INCHES OF WATER

Marshalltown Figure 83 is an extremely sensitive gauge that uses a carefully seasoned bronze diaphragm to accurately measure very low pressures. It is used extensively on many types of natural gas installations for checking low pressures.

Available in standard dials (reading in inches of water) 0-15" -0-30" -0-60" -0-100" -0-160" . . . also in ounce graduated dials from 15 ounces to 5 pounds. 2½", 3½" and 4½" dial sizes mounted in black enameled steel case.

Write for details and price. LOOK TO MARSHALLTOWN FOR ONE OE THE MOST COMPLETE LINES OF INDICATING PRESSURE GAUGES MADE!

MARSHALLTOWN MFG. COMPANY
MARSHALLTOWN 3, IOWA

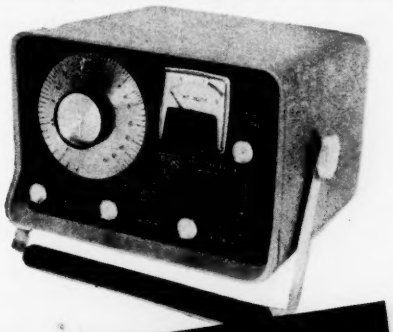
For more information circle **24** on inquiry card.

new from SIE

output meter and calibrated attenuator on front panel

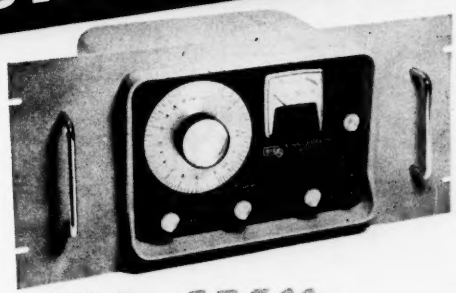
portable · tiltable · rackable

RANGE: 2 cps — 200 kcps
ACCURACY: 2%
OUTPUT: 1 volt
DISTORTION: less than 1%



N-1 signal generator

Another in the line of SIE *Advanced Design Instruments*, human engineered for operating efficiency. Easier to set up • Easier to read • Adjustable viewing angle • Parallax free vernier tuning • Large, easily set control knobs • Protected front panel • Convenient carrying handle.



BENCH OR RACK MODEL 275.00 f.o.b. Houston, Tex

SIE

SOUTHWESTERN INDUSTRIAL ELECTRONICS COMPANY
2831 Post Oak Road • P. O. Box 13058 • Houston 19, Texas

For more information circle **25** on inquiry card.

New DAYSTROM-WESTON MULTI-POINT RECORDER

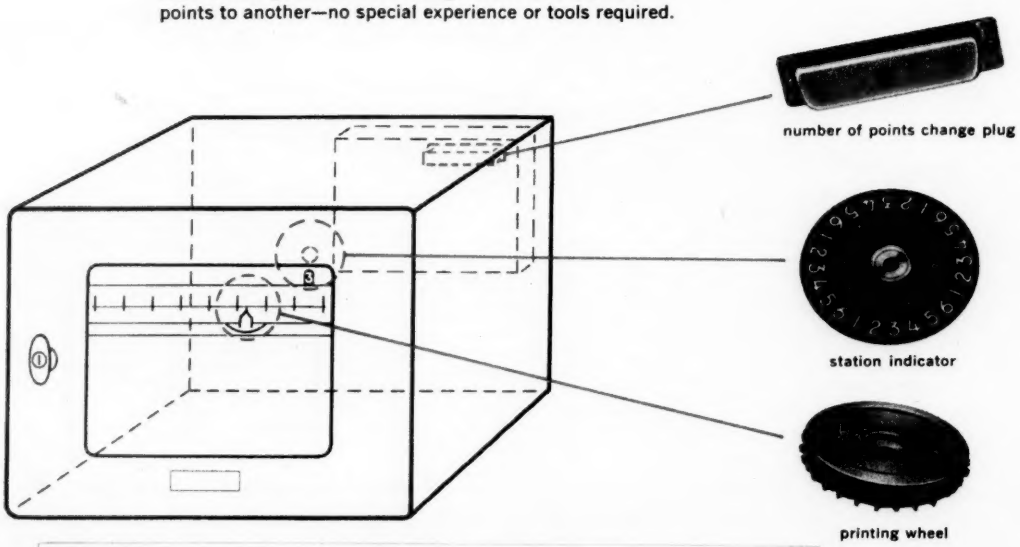
Introduces

INTERCHANGEABILITY—from one number of points to another—one range to another—one chart speed to another.

NEW LOW COST — a single instrument: handling from 2 to 24 points! A single price: 15% less than the average multi-point!

39% SMALLER CASE — with full-size chart and full ¼ of 1% accuracy.

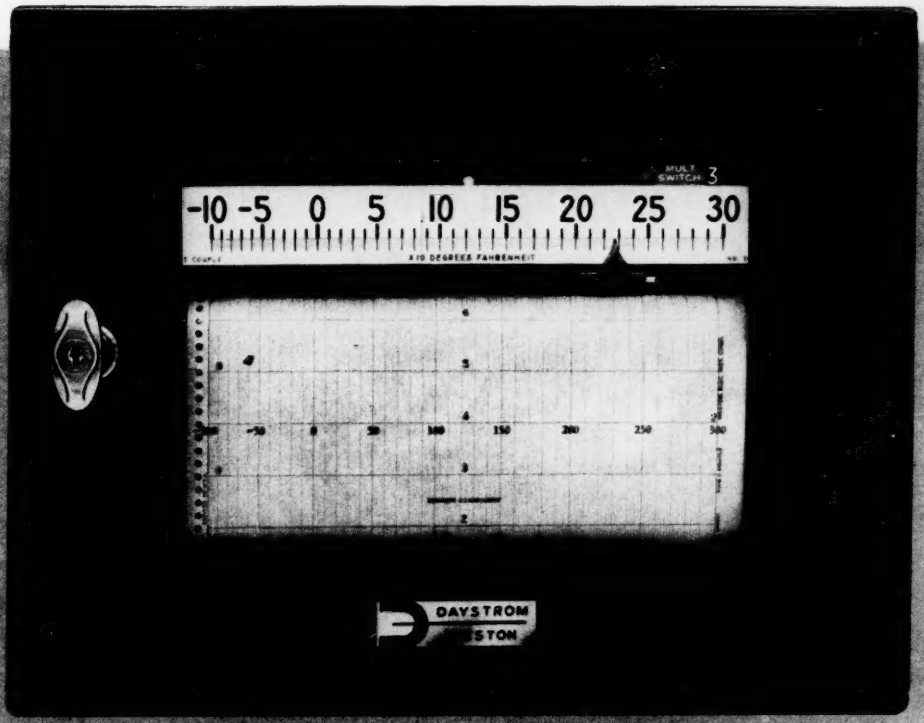
Here is all you need to change from one number of points to another—no special experience or tools required.



SEE THIS RECORDER DEMONSTRATED AT THE ISA SHOW, PHILADELPHIA, SEPT. 15-19

For more information circle **26** on inquiry card.

WITH UNITIZED* design



*** UNITIZATION: the grouping of related components—in Daystrom-Weston Recording Potentiometers—in the simplest, most serviceable, most efficient manner.**

There's tremendous value in this remarkably small instrument—thanks to Weston's *unitized design* and *unique pricing policy*. The size is a big dividend in itself, wherever panel space is at a premium. This is the most compact multi-point recorder—using a full-size chart, and of comparable accuracy (¼%)—ever available. Specially important: a single recorder, offered at a single low price, is easily interchangeable from one number of points to another . . . from one range to another . . . from one chart speed to another! It's so versatile it makes all other multi-point recorders obsolete!

There's none of the clutter or complexity you might expect in an instrument that serves as many functions as this. There's no jungle of wires to hamper inspection and maintenance. Every part is engineered for simplicity—which means trouble-free operation over the years. Components are kept to a minimum, and integrated into compact, rugged panels. Parts are actually more accessible than in much larger instruments.

The new Weston potentiometer recorder accommodates 2, 3, 4, 6, 8, 12, 16 or 24 signals. Changes in the number of recorded points can be made quickly and easily when desired. The unique etched circuit switch is geared directly to the printing head . . . can't get out of synchronization. And this recorder has all of the features that distinguish the other fine instruments in the Weston potentiometer line: simplified range changing with exclusive universal standards . . . high resistance to shock, vibration and corrosion . . . lowest spare parts inventory due to interchangeability of parts.

For more complete information on the Daystrom-Weston *multi-point potentiometer recorder* . . . the *single-point recorder* . . . or the *recorder-controller* . . . call your local Weston representative, or write to Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J. *In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 10, Ont. Export: Daystrom Int'l., 100 Empire St., Newark 12, N. J.*

DAYSTROM-WESTON

Industrial Instruments

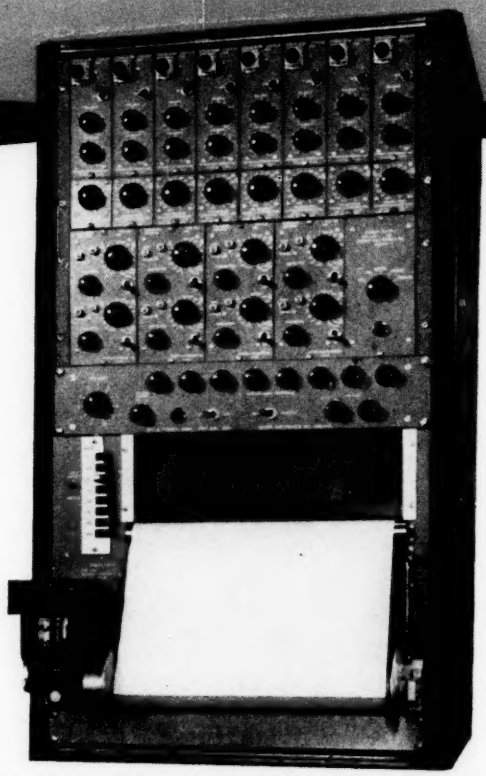
A DAYSTROM UNIT

For more information circle **26** on inquiry card.

OFFNER ALL TRANSISTOR TYPE R DYNOGRAPH

—the most versatile...most sensitive direct writing unit available

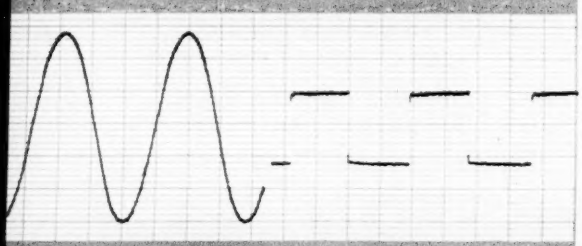
Combining all these features...



- ☆ stable d-c sensitivity of one microvolt per mm
- ☆ true differential input
- ☆ high input impedance
- ☆ response to beyond 150 cps.
- ☆ reluctance, differential transformer, strain gage with a-c or d-c excitation, thermocouples, etc., used with all amplifiers
- ☆ deflection time less than 2 milliseconds
- ☆ fixed precision calibration
- ☆ instant warm-up
- ☆ precision source for d-c and 400 cycle excitation, self-contained
- ☆ zero suppression, twenty times full scale, both directions

all these features...plus 8 channels in only 33¼" of rack space

FULL SCALE, UNRETOUCHED CHARTS PRODUCED ON THE TYPE R DYNOGRAPH



EXTREME SENSITIVITY—

10 Microvolt RMS Sine Wave — **Ten Microvolt D-C Square Wave**

Four recording media. Heat or electric rectilinear —ink or electric curvilinear. Readily convertible.

Whatever your application for direct writing recorders . . . you should investigate the ability of the Offner Type R Dynograph to do the job *better* and more *simply*. Using transistor circuits* developed and tested for over two years in hundreds of channels of Offner medical equipment, the Type R Dynograph is, we believe, superior in practically every respect to *any other* direct writing oscillograph. Write on your company letterhead for literature giving details and specifications.

*Patents granted and pending

OFFNER ELECTRONICS INC.

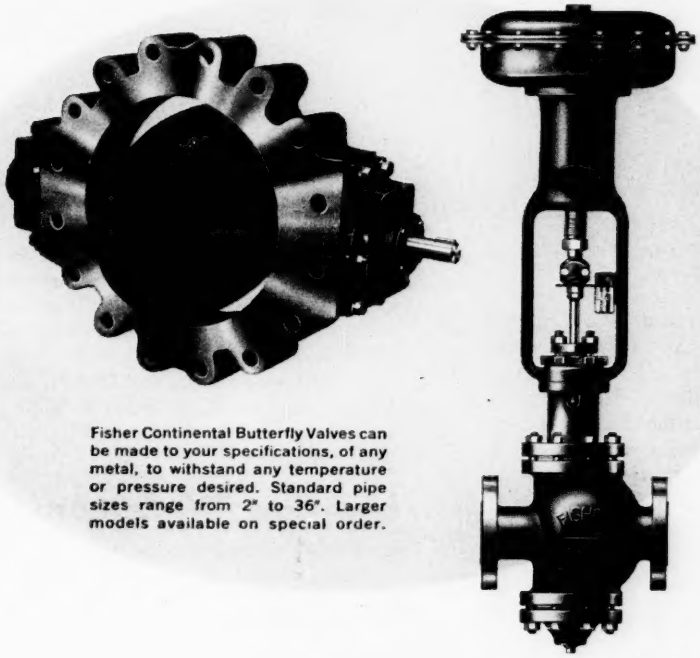
3910 River Road, Schiller Park, Ill.
(Suburb of Chicago)

SEE IT AT INSTRUMENT SHOW—BOOTH 330-332

For more information circle **27** on inquiry card.

NOW FISHER GOVERNOR
PLUS CONTINENTAL EQUIPMENT

an addition that multiplies Fisher's service to industry



Fisher Continental Butterfly Valves can be made to your specifications, of any metal, to withstand any temperature or pressure desired. Standard pipe sizes range from 2" to 36". Larger models available on special order.

With the acquisition of Continental Equipment, Fisher Governor Company is able to expand its service and product offering to its customers.

Continental Butterfly Valves are now available through the Fisher representatives listed at right.

THESE FISHER REPRESENTATIVES CAN SUPPLY YOU WITH CONTINENTAL BUTTERFLY VALVES

AMARILLO
Vinson Supply Company
ATLANTA
J. M. Smither & Company
BALTIMORE
The Rhodes Controls Company
BIRMINGHAM
Joseph W. Eshelman & Company
BUFFALO
W. J. Sommers Company
CALGARY-EDMONTON
Barber Engineering & Supply Company
CARACAS, VENEZUELA
Sinclair Spence
CHARLOTTE
Robert E. Mason & Company
CHICAGO
General Meters & Controls Company
CINCINNATI
H. T. Porter Company
CLEVELAND
A. E. Ehrke & Company
DALLAS
Vinson Supply Company
DENVER
Joy & Cox, Inc.
DETROIT
DuBois-Webb Company
HOUSTON-CORPUS CHRISTI
Puffer-Sweiven Company
INDIANAPOLIS
Acme Engineering Agency
KANSAS CITY
Sullivan-Mears Company
LOS ANGELES
B. R. Jones & Company
LOUISVILLE
Allan K. Cook Company
MARSHALLTOWN
R. S. Stover Company
MEMPHIS
Johnson & Scott
MEXICO, D. F.
Babcock & Wilcox de Mexico
MILWAUKEE
W. D. Ehrke & Company
MINNEAPOLIS
R. G. Read & Company
MONTREAL
Process & Steam Specialties, Inc.
NEW ORLEANS-LAFAYETTE
John H. Carter Company
NEW YORK
Crabbe & Stebbins Company
ODESSA-FARMINGTON
Vinson Supply Company
PHILADELPHIA
Clifford B. Ives & Company
PHOENIX
Cone & Wallace Company
PITTSBURGH
J. G. Chilcoat & Company
PORTLAND
R. H. Brown & Company
RICHMOND
W. H. Kidd Company
ST. LOUIS
H. D. Hale & Company
SALT LAKE CITY
Williams, Gritton & Wilde
SAN FRANCISCO
George R. Friederich & Company
SAN JUAN, PUERTO RICO
Badrena & Perez, Inc.
SEATTLE
Power & Controls, Inc.
SHREVEPORT
John H. Carter Company
TORONTO
George W. Beecroft & Company
TULSA
Vinson Supply Company
VANCOUVER, B. C.
Northern Columbia Process Equipment Co.
WICHITA-LIBERAL
Sullivan-Mears Company
WINNIPEG
Mechanical Valve & Engineering Spec.,

If it flows through pipe anywhere in the world . . . chances are it's controlled by . . .

FISHER GOVERNOR COMPANY

Marshalltown, Iowa / Woodstock, Ontario / London, England

CONTINENTAL EQUIPMENT CO. DIVISION, Coraopolis, Pennsylvania

SINCE 1880

For more information circle **28** on inquiry card.

briefs

Temperature Test Chamber

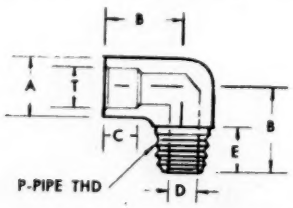
The operation of the Model TC-2A Temperature Test Chamber is shown in the airflow diagram in the Figure. Air is circulated continuously in a closed path past the test load. Heat is absorbed from the circulating air by the evaporation of dry ice (solid carbon dioxide), and heat is added intermittently through a

thermostatically controlled electrical resistance heater. In this manner, a balance may be maintained at any desired temperature between −65°F and that of the room. Above room temperature, dry ice is not required unless the material being tested is a heat source; otherwise, temperatures up to +350°F may be maintained through the balance of heat input against loss through the chamber walls . . . Heat may be added to the circulating air within the chamber by means of a 500 watt maximum capacity strip heater . . . (*From 6-page brochure, Statham Development Corp., 12411 W. Olympic Blvd., Los Angeles 64, Calif.*)

For this literature circle **201** on inquiry card.

Socket Weld Fittings

Where a permanently welded line is desired because of high pressures, extreme temperatures, excessive vibration or other limitations where a mechanical joint is not applicable . . . insert tubing into socket and

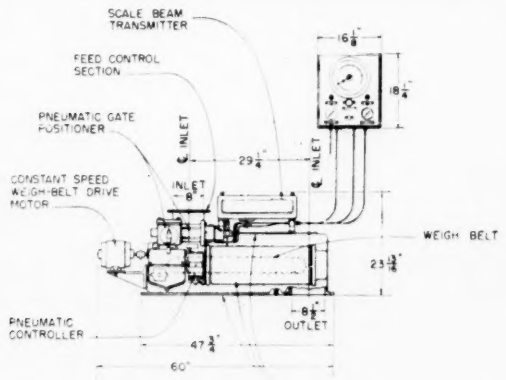


weld. No backing rings or special holding fixtures needed. Deep socket supports and aligns the tube . . . made as standard from type 316 stainless bar and forgings. Other stainless types (including 304 ELC and Carpenter 20), Monel, Nickel, Inconel and Hastelloys furnished as requested . . . (*From new 4-page Bulletin SW 358, The Special Screw Products Co., Bedford, Ohio*)

For this literature circle **202** on inquiry card.

Pneumatic Scale Feeder

The scale is a force balance system which develops a pneumatic signal that is directly proportional to the rate at which material is delivered by the feeder. The air pressure developed by the scale—known as the "measured" pressure—is applied to a pneumatic controller, which compares the "measured"



pressure against a "set" pressure representing the desired feed rate. Any deviation of the "measured" pressure is detected by a pneumatic controller. The pneumatic controller adjusts the pressure output to a pneumatic positioner which controls the opening of a vertical gate in the feed control section. This sensitive control method enables the feeder to maintain a constant delivery of material by weight at the "set" rate . . . (*From new 4-page Publication TP-6-M, Wallace & Tiernan, Inc., 25 Main St., Belleville 9, N. J.*)

For this literature circle **203** on inquiry card.

Low-Cost TV Camera

A basic TE-6-A cemera may be used in a single system including the following: a 1-inch, F2.5 lens, a 14- or 17-inch portable TV receiver, and coaxial cable with matching and isolation transformer for connec-

DIMENSIONS of camera unit (includes control panel and knobs)

	Model 4T56A1	Model 4T56A2	Model 4T56A3
Height	7½ in.	7½ in.	7½ in.
Width	5⅛ in.	5⅛ in.	5⅛ in.
Length	13⅜ in.	13⅜ in.	13⅜ in.
Weight	13½ lbs.	15½ lbs.	15½ lbs.

tion to the TV receiver antenna terminals. This is all the equipment that is necessary to have a simple, low-cost closed circuit television system . . . Other features: . . . Regulated vidicon focus keeps resolution better than 300 lines over line voltage changes from 100 to 130 volts. Crystal-controlled rf frequency minimizes tuning readjustments in multiple receiver installations. . . . facilitates filtering and audio mixing in multi-channel distribution systems. Stable horizontal scanning frequency obtained with transistor L-C oscillator of unique design minimizes drift problem in multi-camera installations . . . (*From new 4-page Bulletin ECL-65, General Electric Co., Electronics Park, Syracuse 1, N.Y.*)

For this literature circle **204** on inquiry card.

Visit us
at the Wescon Show,
Los Angeles, California,
August 19-22, 1958.
Booth Nos. 914, 1228-29

THE NEW LIGHTWEIGHT A-MP "240" PATCHCORD PROGRAMMING SYSTEM

. . . means lightning fast in-flight reprogramming of airborne electrical/electronic circuitry . . . obsoletes fixed circuit connectors and other systems requiring hours or days to rewire . . . and offers these unusual features:

- removable patchboards to permit complete reprogramming in seconds
- 3¼ pounds to minimize weight . . . miniaturized to conserve space
- rugged shock and vibration-resistant construction with high strength aluminum alloy
- shock-resistant seating of patchcord plugs in removable board
- AMP's patented wiping action that pre-cleans contacts for top electrical performance
- 240 contacts for greatest versatility in circuit combinations or program arrangements

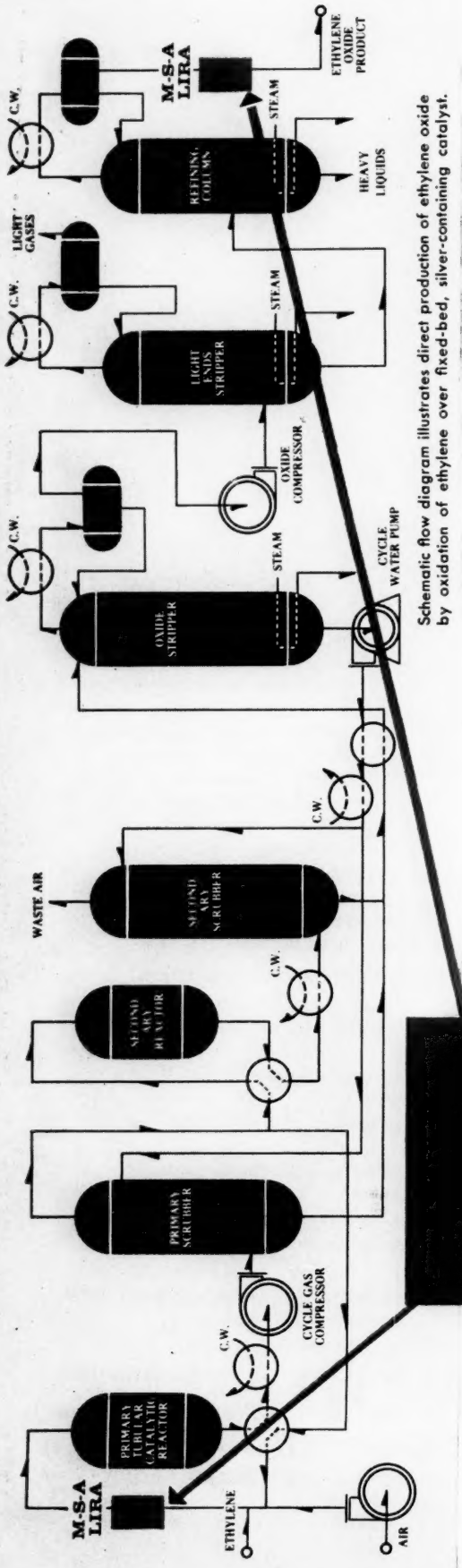
For more information on this new airborne wiring technique, AMP's Patchcord System Catalog is available on request.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

A-MP products and engineering assistance are available through wholly-owned subsidiaries in: Canada • England • France • Holland • Japan

For more information circle **29** on inquiry card.



Schematic flow diagram illustrates direct production of ethylene oxide by oxidation of ethylene over fixed-bed, silver-containing catalyst.

ANOTHER PROBLEM-SOLVING APPLICATION OF M-S-A® LIRA ANALYZERS:

helping to keep reactors operating at peak efficiency in ethylene oxide plants

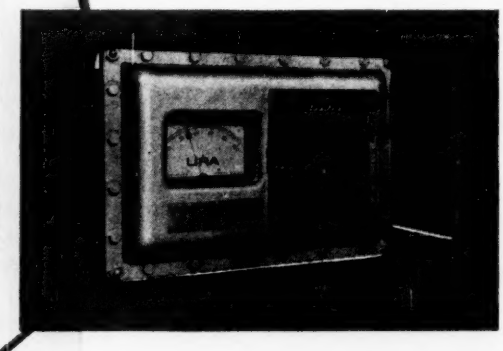
Catalytically oxidizing ethylene to ethylene oxide? You can do it safer, at a greater rate, at less cost by measuring both ethylene input and ethylene oxide product with M-S-A LIRA Model 200 Infra-Red Analyzers

M-S-A LIRA Analyzers can save more than they cost in a matter of months. And they can contribute mightily toward bringing the plant to peak efficiency.

A striking example of this interesting claim is the use of Model 200 LIRA Analyzers in processing ethylene oxide by direct oxidation of ethylene. In this process, LIRAs are used to measure the ethylene in relation to the oxygen input into the reactor. This in turn assures peak operating efficiency of the reactor.

The Model 200 is also used in this process to measure the purity of ethylene oxide being produced as the final product. No need for manual tests for product quality. It's automatic. Continuous. And that's where some of the biggest savings lie. Let's face it: manpower used in process monitoring is expensive. So, let the LIRA do it.

An M-S-A Instrument Specialist will be happy to put our ingenuity to work on your process stream problems: safety, product quality, measurement or control. Consult him. Or write us for helpful literature.



Explosion-proof Model 200 has a tamper-proof lock. All self-checking circuit controls are easily accessible through the explosion-proof enclosure.

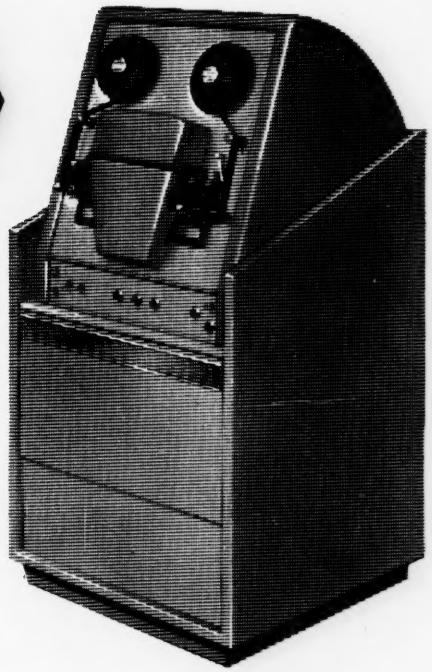
INSTRUMENT DIVISION

Mine Safety Appliances Company
Pittsburgh 8, Pennsylvania

For more information circle **30** on inquiry card.

Burroughs Photoreader

reads this many characters in one second!



1,000 CHARACTERS PER SECOND! And it stops on a single character... then reads the next character within five milliseconds after restart! The new Burroughs Photoreader by ElectroData Division of Burroughs Corporation is now commercially available... the finest precision paper tape reader of such high-speed performance being offered as a component. Speed of the Photoreader introduces a new high in computer-time efficiency to business and scientific data processing. Its instantaneous stop-ability simplifies computer techniques... also brings faster, more efficient operation to missile test checkout, fire control systems, equipment test procedures and machine automation. The Photoreader is adaptable to standard-width tape, from five to eight level code. Economic plastic reels are available in two sizes for tapes of 350 or 700 feet (40,000 or 80,000 Characters). Automatic rewind and end-of-tape sensing; true straight-line loading and drift-free design. Developed as an input unit for the new Burroughs 220 data processing system, the Photoreader is also available as a component for mounting in any standard 19" cabinetry. It may also be ordered already housed in the Burroughs 220 cabinet, as pictured. For complete details write

Burroughs Corporation
ELECTRODATA DIVISION
PASADENA, CALIFORNIA

stops on a single character!

On display ISA Show – September 15-19 – Booth #1045

For more information circle **31** on inquiry card.

LOW COST...

NO LEAKAGE..

with **DeZurik**

Control Valves!

check these important features

Excellent control characteristics

Straight thru flow (reduces erosion and turbulence..... much higher flow capacity than globe type valves)

Rotary stem seal eliminates stem leakage

Absolutely dead tight shut off

Low cost!

The low cost design of DeZurik Control Valves makes it possible to furnish them with a positioner at a cost very often less than an ordinary valve *without positioner!* DeZurik Control Valves are available in sizes ½" thru 20" and in a wide choice of materials. Representatives in all principal cities or write for details.

DeZURIK CORPORATION
SARTELL, MINNESOTA

For more information circle **32** on inquiry card.

Punched Card Sensor

Taurus Punched Card Sensors are ordinarily designed to program data which is punched on standard IBM or Remington Rand code cards.

If you have a large number of programs you need immediate access to (50 and upwards) you should consider using card programming instead of patch boards, for space and economy reasons.

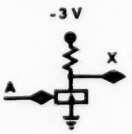
Taurus Sensors can be custom-designed to meet your specific needs. For example, a 100-position Sensor was adapted from the Model K-1. It is now being used to correlate medical diagnostic findings with relevant diseases. The sensor measures 4" x 5" x 7", and weighs less than 4 pounds.

The Sensor is constructed with pins made of Teflon, which open or close corresponding switches. Behind each spring-loaded Teflon pin is a normally closed singlepole single-throw switch. A pre-punched code card is inserted in a slot in front of the pins. When the handle is closed the card is pushed against the pins. The unpunched sections of the card press the pins into the switches and open them. The remaining pins slip through the holes punched in the card and leave these switches closed. Switches are actuated simultaneously, and remain actuated until the handle is opened . . . The switches have been cycled over ½-million times, and maintained contact.—(*From new 4-page brochure, Taurus Corp., 8 Coryell St., Lambertville, N. J.*)

For this literature circle **205** on inquiry card.

5-Mc Digital Blocks

DEC Building Blocks are a coordinated set of fully transistorized 5-megacycle digital computer circuits. They are used to build semi-permanent digital systems, and for testing and developing digital systems and components. All logical signals are available on the graphic front panels of the units, while the standard



power connections are made from the back. Logical interconnections are made with patch cords using miniature stacking banana jacks . . . All models use the same three power voltages (−3v, −15v and +10v), thus allowing any arrangement of building blocks in the mounting panel. The standard DEC pulse is −2.5 volts in amplitude and 70 millimicroseconds or less in width. Standard levels of 0 and −3 volts are used for all logical operations . . . logical operations are performed by combinations of saturable transistor inverters. The user can consider these as simple switches . . . (*From new 4-page Bulletin M10-85-3A, Digital Equipment Corp., Maynard, Mass.*)

For this literature circle **206** on inquiry card.

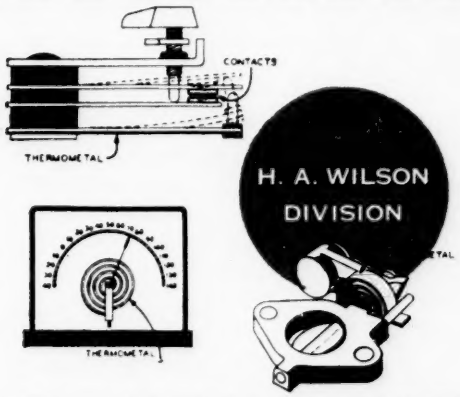
FOR A MIRROR BRIGHT FINISH

"SILVA-BRITE" SILVER PLATING PROCESS . . . Provides hard, bright, highly-ductile finish in stable deposits from flash to heavy. Water-clear solution enables plater to watch process; parts falling into tank may be recovered without contamination. Uniformly good results with current densities from 10 to 40 amperes per square foot; operation and control are non-critical, economical. Filtration through activated carbon removes organic contaminants; no purification downtime. Excellent throwing power, less tendency toward bath decomposition or fumes. Write for technical bulletin.

American Platinum & Silver Division, 231 New Jersey Railroad Avenue, Newark 5, N. J.

For more information circle **33** on inquiry card.

FOR CONTROLLING TEMPERATURE



THERMOMETAL® . . . for use in electrical appliances, thermal cutouts, heating controls . . . in any application involving the indication and accurate control of temperatures, electrical currents, voltages, etc. Supplied in strip form, rolled and slit to close tolerances and tempered to meet specifications. Also supplied as elements and sub-assemblies, with or without contacts attached, fabricated in accordance with specifications.

H. A. Wilson Division, U. S. Highway No. 22, Union, N. J.

For more information circle **34** on inquiry card.

FOR PURIFYING AND PURIDRYING

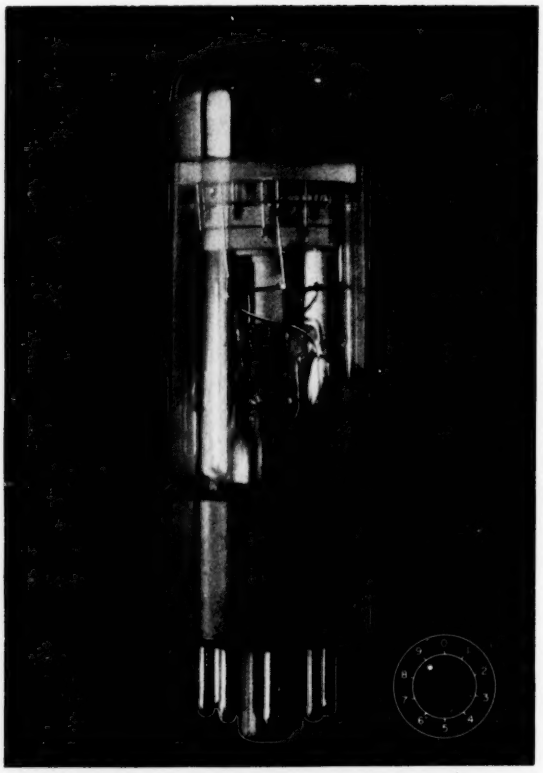
DEOXO® PURIFIER . . . provides low-cost catalytic purification of hydrogen and other gases to the extent of less than one part oxygen per million. Requires no operating expense, no maintenance, no reactivation, no auxiliary heating, no water cooler. DEOXO® DUAL PURIDRYER . . . combines continuously-operating, dual tower, automatically-run drying unit with the features of Deoxo Purifier—catalytically produces pure, dry hydrogen, so pure it contains less than one part oxygen per million, so dry that it has a dew point of better than —100° F.

Chemical Division, 113 Astor Street, Newark 2, N. J.

For more information circle **35** on inquiry card.

ENGELHARD INDUSTRIES, INC.

113 ASTOR STREET
NEWARK 2, NEW JERSEY



Need a **PROVEN** tube that indicates and counts?

dekatron*

The only cold-cathode glow transfer counting tube **WITH OVER 10 YEARS OF SERVICE RELIABILITY AND PERFORMANCE.** Simple circuitry. Electronic speed and accuracy up to 20,000 counts/sec. For counting, sorting, programming, unit flow, packaging and many other applications. Continuous visual reference to total count. For detailed information, request Technical Data Sheet IC4001.

*Trademark

Baird Atomic

Baird-Atomic, Inc.

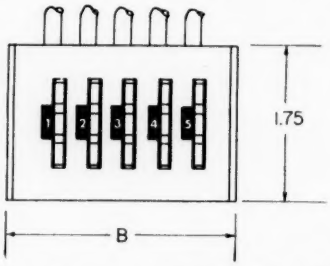
33 UNIVERSITY RD., CAMBRIDGE 38, MASS.

Instrumentation for Better Analysis

For more information circle **36** on inquiry card.

Digiswitch

Model 7110 Digiswitch is a 3 or 5 decade switch featuring single and double pole, as well as binary-coded switch configurations for each decade (contact



ratings 200 volts and 1 ampere). The desired switch position is selected by rotating the knurled knob. DIGISWITCH allows operator to read only the numbers that are visible—replacing ordinary switches with arrow indicators or standard indicator dials . . . (*From 2-page Bulletin T.D.7.31—7110.1. The Digitran Co., 45 W. Union St., Pasadena, Calif.*)

For this literature circle **207** on inquiry card.

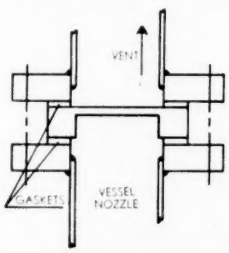
Differential Producer Throats

This bulletin presents a straightforward method of selecting throats on all the velocity-increasing type differential producers made by Builders-Providence, Inc. While the method is approximate, it is felt that it is sufficiently accurate for the purpose of determining (1) throat size, (2) head loss, and (3) whether or not standard throats can be applied to applications involving steam, gases and liquids not covered by tabulated capacities . . . (*From new 12-page Technical Bulletin 100-P6 which includes curves showing beta ratio, recovery characteristics, etc. for basic types of primary elements, Builders-Providence, Inc., 345 Harris Ave., Providence 1, R. I.*)

For this literature circle **208** on inquiry card.

Graphite Rupture Disks

Impervious graphite disks are non-contaminating, non-porous, immune to effects of thermal shock, and are unaffected by the action of practically all corrosives . . . features almost 100% breakout of pressure



membrane to allow maximum opening for safe escape of excess pressure . . . can be used up to 75% of rated burst, which reduces the required range of pressure vessel design in relation to the rupture disk burst pressure . . . (*From new 4-page Bulletin 315-1, Falls Industries, Inc., Aurora Rd., Solon, Ohio*).

For this literature circle **209** on inquiry card.

...the record tells you more

from a SANBORN SYSTEM

DESIGNED SPECIFICALLY FOR YOUR TYPE OF WORK

MODEL 276 CHART VIEWER

Permits convenient, variable speed editing and study of Sanborn charts and other types up to 16" wide, 200 ft. long. Single control for direction, paper speeds (15" to 100"/min). Transparent cursor slides left or right, adjusts for accurate alignment with coordinates.

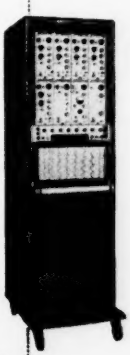
1- TO 8-CHANNELS, 12 PLUG-IN PREAMPLIFIERS

150 SERIES

Features of the "150 series" direct writers include: frequency response to 100 cps; linearity 1% overall; inkless recording in true rectangular coordinates by heated stylus on plastic coated Permapaper charts; current feedback driver amplifier and regulated power supply for each channel. Recorder has 9 chart speeds, 0.25 to 100 mm/sec; individual stylus heat controls, time-code marker. Up to 6-channels can be housed in one vertical cabinet. Amplifiers, recorder also available in individual portable cases.

6-, 8-CHANNELS, FLUSH FRONT RECORDER, FREQUENCY RESPONSE TO 120 CPS

350 SERIES



New "350" series direct writers with compact plug-in preamps in modules of up to 4; individual power supplies; current feedback transistorized power amplifiers; limiter circuit ahead of power amplifiers; velocity feedback galvanometer damping; enclosed galvanometers. Linearity 0.2 div over entire 50 divisions. Recorder-power amplifier-power supply package has 0.1 volt/div. sensitivity, can be used separately; pushbutton controls for 9 chart speeds 0.25 to 100 mm/sec; individual stylus heat controls; contacts for remote control; inkless rectangular coordinate recording on Permapaper charts.

6-, 8-CHANNELS

850 SERIES

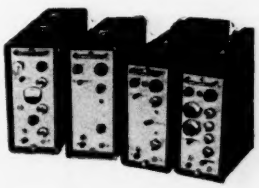
Compact "850" series direct writers use 7" high plug-in preamplifiers in modules of up to eight and "350" flush front recorder package with transistorized power amplifiers, power supply; features velocity feedback galvanometer damping, linearity 0.2 div. over entire 50 divisions; 9 chart speeds from 0.25 to 100 mm/sec controlled by electric pushbuttons; inkless recordings on Permapaper charts. Available preamps include Servo Monitor (demodulator) and DC Coupling. Carrier, Chopper Stabilized and Low Level types are in development.

COMPUTER READOUT . . . AUTOMATIC PROGRAMMING

150 SERIES

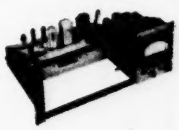
"150 series" 6-, 8-channel consoles in 46½" high mobile cabinet. Dual-Channel Amplifiers have selectable sensitivity from 0.01 to 10 volts/div.; internal calibration 2 volts ±1% freq. response flat to 20 cps. Optional Programmer sequences system operation in 20 steps, including recorder turn-on, calibration, computer DC level reading, recording for pre-set time, turn-off and reset.

SELF-CONTAINED UNIT PREAMPLIFIERS TO DRIVE 'SCOPES, OPTICAL OSCILLOGRAPHS, TAPE RECORDERS, ETC.



Portable "350" series include Carrier, DC Coupling Servo Monitor (demodulator), True Differential DC types; others in development. Mount in portable "450" cases or in four-unit modules in 19" frame. Use individual power supplies. One "450" case and power supply can serve any "350" Preamp.

PORTABLE INDICATORS FOR STRAIN, ETC.



Model 150-300/700 Wide Band Amplifier and Power Supply accepts "150" series preamplifiers — for use with low power galvanometers, oscilloscopes, panel meter. Freq. range DC to 10,000 cps (but limited by particular preamp range). Panel meter has center zero scale, 25 divisions each side of center.

(ALL DATA SUBJECT TO CHANGE WITHOUT NOTICE)

For complete data, call your local Sanborn Engineering Representative or write the Industrial Division in Waltham.

SANBORN COMPANY

Industrial Division

175 Wyman Street, Waltham 54, Mass.

Visit Sanborn Booths 1454-1455 at Wescon Show

For more information circle **37** on inquiry card.

GPE — technological bumbershoot

Covering the advanced needs of industry and defense is today's biggest technological job.

GPE has brought together, under one umbrella, broad physical resources plus a remarkably creative group of scientists, engineers and technicians. Its co-ordinated skills, knowledge, experience and producing facilities cover more than a dozen industries.

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GENERAL PRECISION EQUIPMENT CORPORATION

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The principal GPE companies cover needs of defense and industry in these areas: Audio-Visual, Automatic Controls and Automation, Aviation, Chemical Processing, Electronic and Electrical, Graphic Arts, Instrumentation, Marine, Motion Picture, Packaging, Paper, Petroleum, Photo Technology, Power Generation and Conversion, Printing, Steel, Television, Textile.

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General Precision Equipment Corporation

92 GOLD STREET, NEW YORK 38, N. Y.

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Panhandle Pete

Bridging The River Cry

EVERYBODY knows that the gap between science and humanity is just terrible, and meetings between big shots in science and the humanities are being planned to do something about it.

Working quietly and diligently, WESCO! has pulled the scoop of the year; it has bridged the gap between science and humanity with no less than 64 scientists and 57 human beings—er, humanists . . er humanitarians, or whatever you call nuts who study nothing but art, philosophy, and other fool—er nonscientific subjects.

This historic meeting was held last week and the gap is now bridged. It wasn't easy, either.

First off, we had Otto U. Alles, BS, MS, Phd, CORG, etc., our genial research director, speak on the need for this meeting. He had a little trouble with his English (as you all know, Otto was borrowed from our overseas allies because of his vast knowledge in the field of missiles—he invented the buzz bomb—and can't speak English so real good yet) but he finally got it out somehow that they were all in that room in order to close that gap, that intercourse between scientists and human beings is the way to do it, and that the gap just had to be bridged or else scientists won't have a world in which to practice their science, and that that at least should concern all scientists. Then he asked for suggestions.

That started it. Mr. Flannelgirdle, Chief Engineer in charge of Un-Guided Missiles at WESCO! said that the gap should be bridged with more and better science, that technical schools should be expanded, that science courses should be harder, lab hours longer, that there should be more concentration on essentials, like math and nuclear physics.

"Oh for heavens sake!" yelled a long-haired social worker, "What are you trying to do, turn the little stinkers into creeps like you? Any body with sense knows that the bulwark of civilization lies in the study of culture and the improvement of man's moral life. What we need is more religion, philosophy, arts, and . . ."

"All that easy social science and liberal arts stuff is ruining the kids of the nation and making them soft in the head," yelled the engineers.

"Oh shut up and sit down!" shouted a group of mechanics and salesmen. "Who's going to do the work if you teach the kids a bunch of guff like that, huh? All youse guys is wrong; what we need is more emphasis on hardware, manual training, and the likes of that. Why there are millions of people who haven't got indoor plumbing yet and . . ."

Well these groups were going at it hot and heavy when the educators pulled a sneaky trick and turned on a WESCO! 50-watt amplifier and blared out a question—"How in h . . . can you add even one more course to a curriculum that students can't handle now? And when are we going to get more teachers? And also, would the glorious assembly there please sign a name-calling letter addressed to all Congressmen in Congress who just killed the fourth bill that would have diverted a few boondoggle billions into teachers pay and more schools."

That did it. The silence that settled over that crowd almost kept the gap from being bridged right then and there. But our own genial sales manager Waldo Klapsaddle, Jr., showed what a genius he is—he jumped right up and said, "I move that we expand the study of science *and* the humanities *and* the social sciences simultaneously and with no interference from the government, that we develop a national respect for knowledge and the American way of life, and that we stimulate all young people into the paths of education and righteousness for the good of the country."

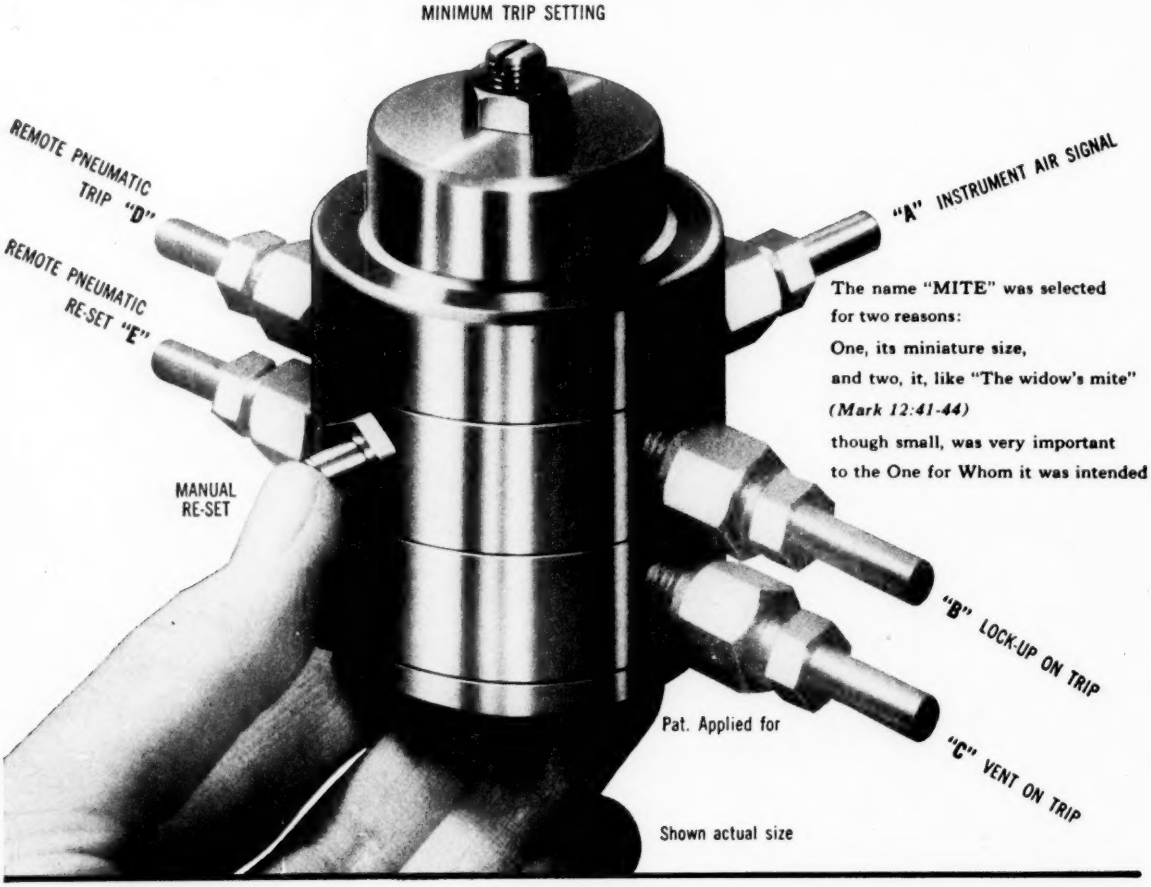
You would not have believed it. All those squabbling and fighting and bickering people just all stood up and voted "I do." Everyone of them, just like that, and the meeting adjourned on a note of complete harmony and accomplishment.

So WESCO! is happy to announce that the gap between science and humanity is now bridged. All those other meetings scheduled to bring scientists and human beings together now can be called off. WESCO! again does it first!

Panhandle Pete

"MITE" 73

Announcing the First Item in Our New Line of Control Instruments.



The name "MITE" was selected for two reasons:
One, its miniature size,
and two, it, like "The widow's mite" *(Mark 12:41-44)* though small, was very important to the One for Whom it was intended

The "MITE-73" is a monitor instrument designed to trip when a pneumatic signal violates its minimum or maximum* setting. It remains tripped after the signal is restored to normal limits until manually reset, either locally or remotely. When in service "MITE-73" will relay the input signal "A" to either one or both ports "B" & "C". (Either "B" or "C" must be plugged if not required.)

"MITE-73" is available in anodized aluminum, brass or 18-8 stainless steel.

Standard maximum pressure range 250 P.S.I., minimum trip adjustable 1-100 P.S.I.

From the above graphic description you will note the "MITE-73" has, like the common safety pin, many applications.

*If desirable to have the "MITE-73" trip on a maximum setting, tee off from A to D with a relief valve in the loop and set trip pressure desired.

REPRESENTATIVES IN PRINCIPAL CITIES
Write us for complete technical information, or for the address of our representative in your area.

GEORGE W. DAHL COMPANY, INC. 86 TUPELO STREET, BRISTOL, R. I.

For more information circle **67** on inquiry card.

Miniature plug-in Relay for printed circuits

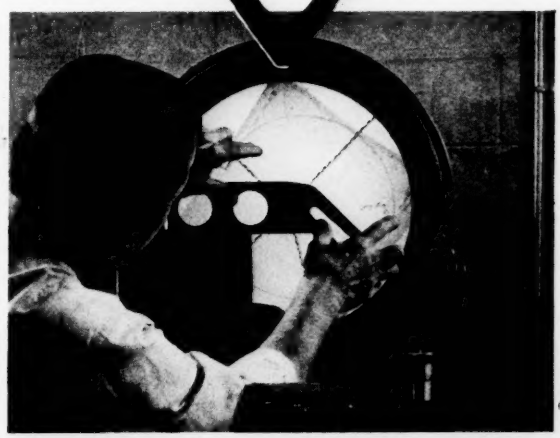
SQPC Relay—Length, 1 3/4"; height, 1 5/16" to 1 3/4" (depending upon number of springs); width, 1".

...millions of operations without attention!

Need a dependable relay for direct insertion into printed circuits? Automatic Electric's new Printed-Circuit Relays run *up to 120 million operations without a single readjustment or relubrication!*

Miniaturized without sacrifice of ruggedness, these *SQPC* Relays, with reinforced mounting, deliver reliable performance under extreme conditions – dependable contact operation at up to 10.5 G's, 25 G's shock, and temperatures from −55° to +85°C.

SQPC Miniature Printed-Circuit Relays are available with many different contact spring arrangements–can be permanently secured with any acceptable soldering technique.



RELAY SPRING TAKING ITS "PHYSICAL." A technician explores critical spring areas for tool marks and concealed defects–calibrating radii to .001 inch–checking for the strength and stamina which will assure long, uniform service life. Automatic Electric quality control is unmatched in the industry–a compelling reason why you should specify AE in your engineering.

Save parts, assembly and wiring time by using printed circuits–and Automatic Electric SQPC Relays. For full details, write or call: Automatic Electric Sales Corp., Northlake, Illinois. *In Canada:* Automatic Electric Sales (Canada) Ltd., Toronto. *Offices in principal cities.*

AUTOMATIC ELECTRIC ®

Northlake, Illinois • Subsidiary of **GENERAL TELEPHONE**

For more information circle **39** on inquiry card.

an Epsco transistorized

TRANSICON DATRAC®

can solve your data conversion problem . . . economically!

designed FOR YOUR SYSTEM by system specialists who have pioneered the field of high-speed, reversible analog-to-digital conversion . . .

- **PRODUCTION ENGINEERED** to be the lowest-cost transistorized converters available anywhere.
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- **HIGH SPEED**—up to 25,000 conversions/sec analog-to-digital; up to 100,000 conversions/sec digital-to-analog
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. . . and an Epsco Exclusive: PROVEN RELIABILITY One million hours of operation in hundreds of installations around the world have proven DATRAC reliability. Now an all solid state TRANSICON DATRAC assures even greater performance.

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Digital Transmission over Telephone Lines
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TRANSICON ALARM LIMIT MONITORS FOR . . .

Automatic Checkout Systems
High-speed Fault Analyzers
Power Plant Monitors
Industrial Process Controllers

Epsco

First in data control

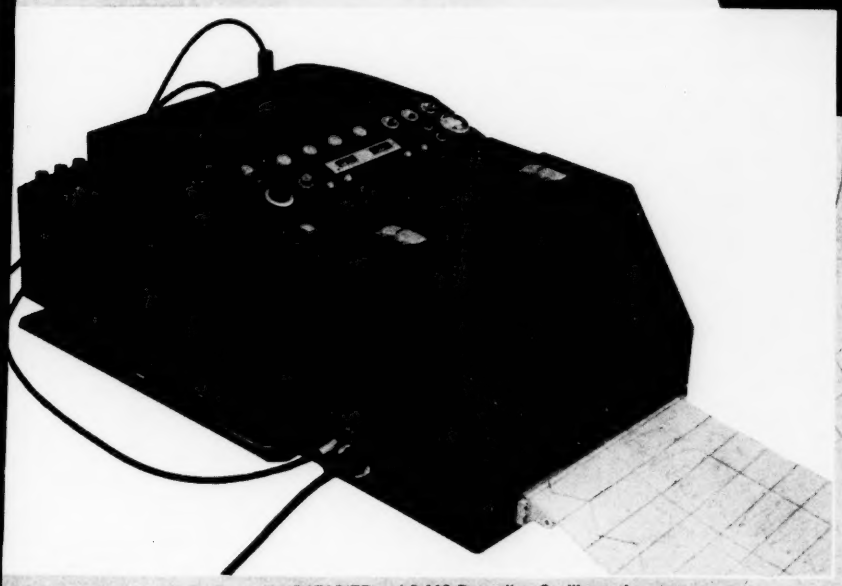
For more information circle **40** on inquiry card.

Circle **41** on inquiry card. ⟶

This is what we mean by
rapid-access

DATARITE

This instrument places visible, developed, dry and ready-to-use oscillograph records in your hands within 0.8 seconds after exposure.



DATARITE and 5-119 Recording Oscillograph

...only DATARITE can offer... visible records at the instant the paper emerges from the magazine exit... no further processing... unmatched trace contrast and clarity... a *true* rapid-access magazine which uses standard commercially available thin-base recording papers ...400-ft. record capacity... internal flash processing with a single chemical solution... no toxic chemical sprays or vapors... standard light source... oscillograms which can be easily duplicated by any conventional process... permanent test results continuously *while* the test is in progress.

DATARITE Magazines directly replace the standard magazines of both the 5-119 and 5-114 Recording Oscillographs without special attachments or modifications.

These combinations provide a unique, transportable recording instrumentation package for on-the-spot analysis of complex military and industrial systems. For complete information on DATARITE — on how to eliminate testing-bottlenecks — contact your nearest CEC field office, or write for Bulletin CEC 1598-X21.

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Veeder-Root Panel-Mounted High Speed Electrical Counters

...with electric resetting in 1/10th of a second

These new Series 1591 Electrical Counters fill the gap between standard and electronic counters for industrial, data processing, or laboratory and scientific uses. They're designed for accuracy and long life at very high speeds (rated at 3000 counts per minute, with extended test-runs up to 6000 cpm).

And they have the unmatched convenience of *instant push-button resetting*, either mechanically right on the machine . . . or electrically from a distance. Panel-groups of these counters can be placed right in your office . . . *and one button can reset an entire panel.* Counters feature large figures, small size, low-wattage coils for continuous duty and other V-R vantage points on which patents are pending.

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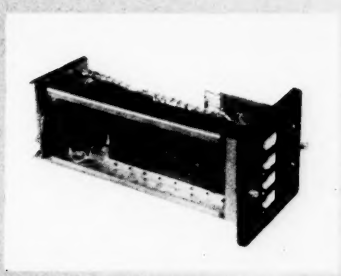
For more information circle **42** on inquiry card.

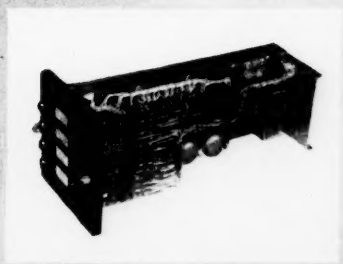
THOMAS A.

EDISON

New printed circuit model 310 omniguard temperature monitor



PRINTED CIRCUITRY INCREASES RELIABILITY AND FLEXIBILITY.



USE OF THE HIGHEST QUALITY COMPONENTS INCREASES RELIABILITY . . . ASSURING MAINTENANCE-FREE OPERATION.

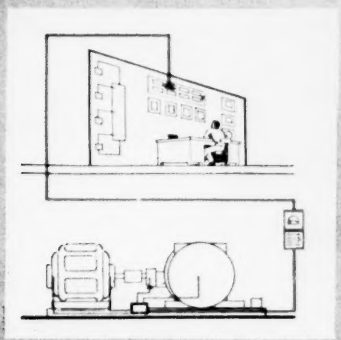
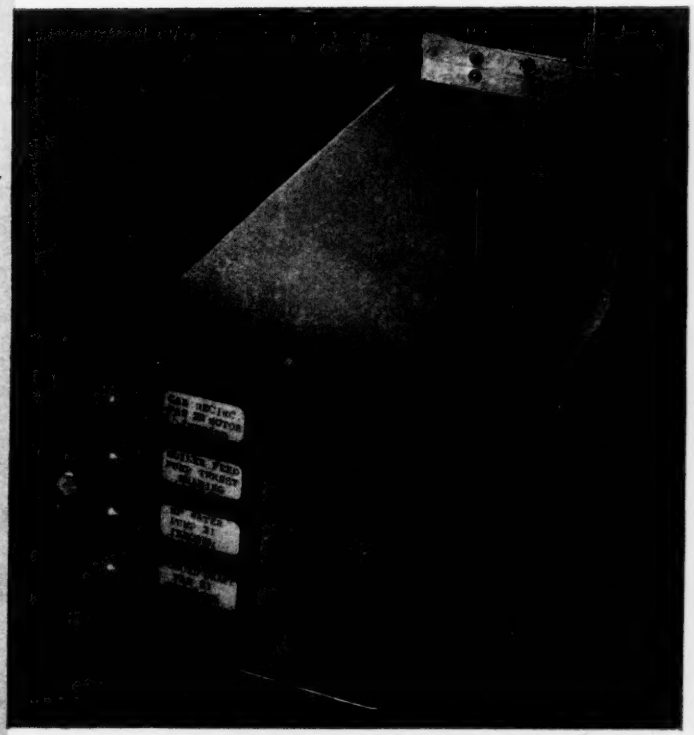


DIAGRAM SHOWS TYPICAL OMNIGUARD SYSTEMS.



New Versatility . . . and *proven reliability* in temperature detection is made available with the introduction of the new Model 310. Printed circuit design and quality components guarantee a minimum of maintenance for the life of the unit.

Now, you have a temperature monitoring system incorporating all the flexibility, simplicity, quality and economy instrument and systems engineers have needed. The Edison Model 310 is a *mass produced* system whose modular construction makes it possible to have *custom-tailored* installation. Other important features of the new Omniguard Model 310:

- **Design keeps pace with growing instrumentation.**
- **Eliminates corrective maintenance and downtime.**
- **Complete Unit plugs in.**
- **Designed for more than a million operations.**

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INSTRUMENT DIVISION

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EDISON FACTORY OFFICES ARE LOCATED IN: EVANSTON, ILLINOIS; DALLAS, TEXAS; DAYTON, OHIO; SHERMAN OAKS, CALIFORNIA.

For more information circle **43** on inquiry card.

New polyvinyl T/c extension wire resists moisture and combustion

. . . available through your HSM HONEYWELL SUPPLIES MAN

HERE'S a thermocouple extension wire with superior insulation. Each of the two solid conductors is insulated with .015″ polyvinyl, and the pair is further protected by an outer .02″ polyvinyl jacket. It's the ideal wire for even the toughest service. What makes it better than ever is a *new kind* of polyvinyl insulation that adds extra serviceability.

Ask your local HSM (Honeywell Supplies Man) to tell you about this new wire . . . and to discuss how the HSM Plan can bring new convenience and economy to all your pyrometer supplies purchases. Call him today, at your local Honeywell office . . . as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Check these features:

WON'T BECOME TACKY or stick to conduit walls, even when overheated.

WON'T SUPPORT FLAME. Fire merely chars the coating. You can rewire without replacing the conduit.

ABRASION-RESISTANT. Jacket won't break or fray in roughest service.

EASY TO PULL THROUGH CONDUIT because jacket is smooth.

WEATHER-PROOF . . . double vinyl insulation gives extra protection.

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● **REFERENCE DATA: Write for Specification S002-1, and for Pyrometer Supplies Buyers' Guide No. 100-6.**

Honeywell

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First in Control

events

Sept. 3-5

NEMA and AIEE First National Conference on Application of Electrical Insulation, Cleveland, Ohio. For information write George Bamberg, The Glastic Corp., 4321 Glenridge Rd., Cleveland 21, Ohio.

October 8-10

Network Analyzer Short Courses, sponsored by the Engineering Extension Service, Iowa State College, Ames, Iowa. For information write Ralph E. Patterson, Jr., 110 Marston Hall, Iowa State College, Ames, Iowa.

Sept. 3-10

International Association for Cybernetics Second International Congress Namur, Belgium. For information write Secretariat, 13, rue Basse-Marcelle, Namur, Belgium.

Sept. 8-13

First International Congress of the Aeronautical Sciences planned by the International Council of the Aeronautical Sciences, Madrid, Spain. For information write Institute of Aeronautical Sciences, 2 East 64th Street, New York 21, N. Y.

Sept. 15-19

13th Annual Instrument Society of America Conference and exhibit will be held in Philadelphia. For further information contact H. S. Kindler, Dir. of Technical Programs, Instrument Society of America, 313 Sixth Avenue, Pittsburgh 22, P

Sept. 15-17

AIEE Power Industry Computer Application Conference, King Edward Hotel, Toronto, Canada. For information write J. R. Leslie, Ontario Hydro, 620 University Ave., Toronto 2, Ontario, Canada.

Sept. 22-24

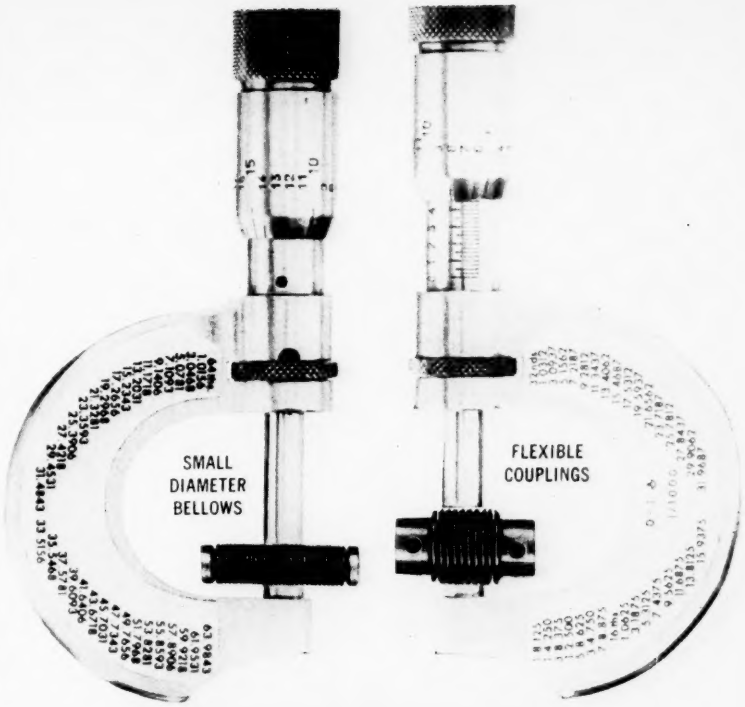
Symposia and exhibits of The Professional Group on Telemetry and Remote Control of the IRE, Americana Hotel, Bal Harbour, Miami Beach, Fla. For information write Conrad H. Hoeppner, Radiation Inc., Melbourne, Florida.

Sept. 24-25

Seventh Annual Symposium on Industrial Electronics, of the IRE Rackham Memorial Auditorium, Detroit, Michigan. For information write William R. Thurston, IRE Professional Group on Industrial Electronics, General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

September 8-10

IRE Canadian Convention and Exposition on Electronics and Nucleonics, Exhibition Park, Toronto, Canada. For information write Convention Mgr., 1819 Yonge St., Toronto 7, Canada.



MINIATURIZE WITH BRIDGEPORT

Looking for new ways to save space and weight in instruments, aircraft, missiles and other equipment? Investigate these two miniature products by Bridgeport:

Small Diameter Metallic Bellows, only ¼" and 5/16" O.D., provide exceptional strength, precision and sensitivity to temperature and pressure changes. Hydraulically formed without seams to your strictest specifications in a wide range of bellows metals, physical properties and performance characteristics. Available in unlimited quantities.

WRITE FOR BULLETIN F-108.

Small Diameter Flexible Couplings, available from stock, in several metals and sizes as small as 15/32" O.D. . . . smaller diameters custom-engineered on request. Eliminate back-lash, maintain uniform angular velocity, reduce bearing wear and friction in a variety of applications. Stock couplings accommodate shaft sizes ⅛" to ½" diameter.

WRITE FOR DATA SHEET F-808.

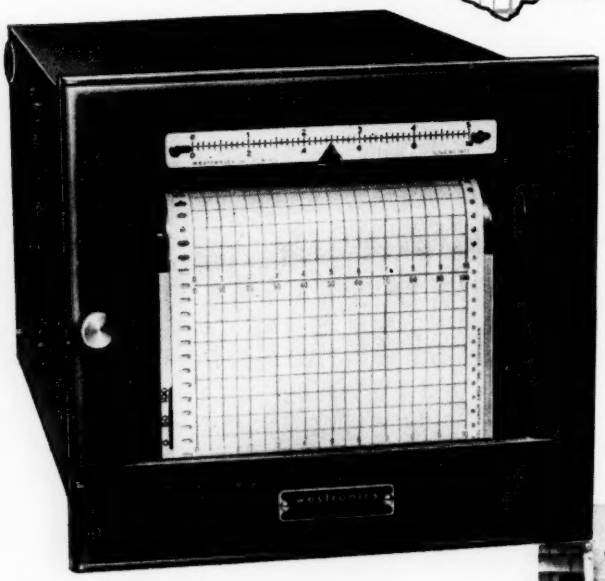
Air Controls

Robertshaw-Fulton CONTROLS COMPANY

BRIDGEPORT THERMOSTAT DIVISION • Milford, Conn.

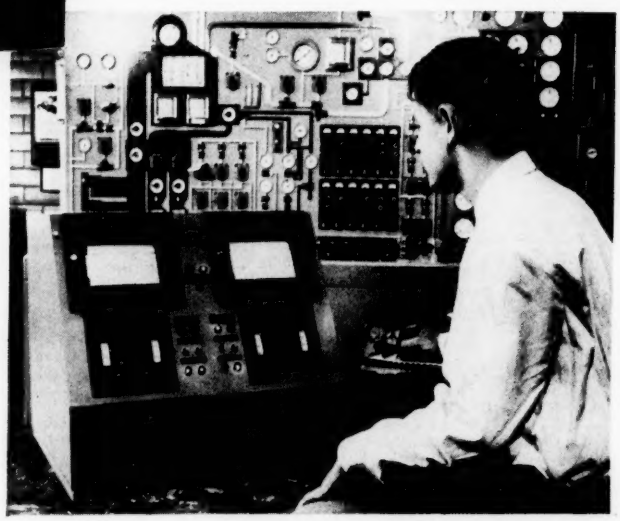
For more information circle **44** on inquiry card.

when data means dollars . . .



Be sure that your data is accurate. Westronics' rugged Single Pen* Miniature Recording Potentiometer is better than 0.5% accurate, with a one second full scale pen travel.

This compact recorder, fits in 9¾" x 8½" panel space, has more optional features than any other small recorder built today. The front and back set limit switches, plug-in range units, and transmitting slidewire are among the optional features of the Westronics Single Pen Miniature Recording Potentiometer which adapt this recorder to a variety of uses. The recorder is widely used by many industrial plants and missile testing operations.



PRICED ONLY

$490.00

IMMEDIATE DELIVERY

Send for literature

*Miniature Dual Pen Recorders of same dimensions also available.

westronics INCORPORATED

FORT WORTH, TEXAS 3605 McCART STREET Phone WA 3-8211

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Oct. 13-15

1958 National Electronics Conference —the 14th Annual Forum on Electronic Research, Development and Application sponsored by the American Institute of Electrical Engineers, Illinois Institute of Technology, Institute of Radio Engineers, and Northwestern and Illinois Universities, Hotel Sherman, Chicago. For information write National Electronics Conference publicity chairman, c/o Illinois Bell Telephone Co., 208 W. Washington St., Chicago 6, Ill.

October 13-15

1958 International Systems Meeting, Hotel Penn-Sheraton, Pittsburgh, Penna. For information write A. M. Motter, Jones & Laughlin Steel Corp., #3 Gateway Center, Pittsburgh 30, Penna.

Oct. 14-16

Annual Exposition Competition and Short Course sponsored by the Society of Industrial Packaging and Materials Handling Engineers, Chicago Coliseum, Chicago. For information write G. Cornwall Spencer, 327 S. LaSalle St., Chicago 4, Ill.

Oct. 22-24

Fifth National Vacuum Symposium of the American Vacuum Society, Sir Francis Drake Hotel, San Francisco, Calif. For information write Wilfrid G. Matheson, 60 Boston St., Salem, Mass.

October 22-26

Third Conference and Exhibit of Instrumentation and Automation, Palazo dell'Arte al Parco (Triennale), Milan, Italy. For further information contact Strumentazione e Automazione, Via Marcona 15, Milan, Italy.

October 27-28

Radio Fall Meeting of the Electronic Industries Association, Sheraton Hotel, Rochester, N. Y. For information contact the EIA office, 11 West 42nd St., N. Y. 36, N. Y.

October 29-30

Fifth Annual Computer Applications Symposium sponsored by Armour Research Foundation, Morrison Hotel, Chicago, Ill. For information write F. C. Bock, Armour Research Foundation of Illinois Institute of Technology, Technology Center, 10 West 35th St., Chicago 16, Ill.

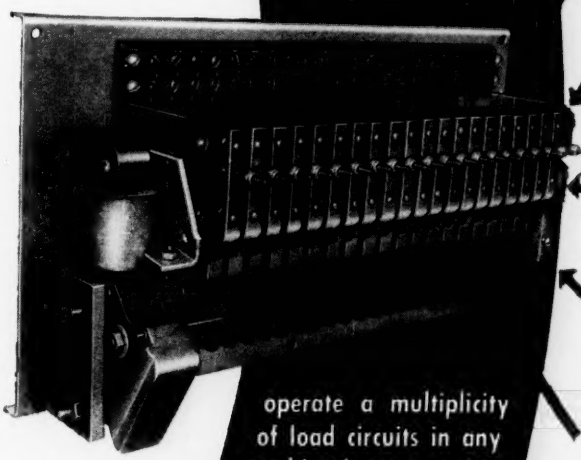
October 30-31

Fourth Electronic Business Systems Conference sponsored by the Western Division, National Machine Accountants Assoc., Olympic Hotel, Seattle, Wash. For information write Jack Armstrong, P. O. Box 134, Seattle 11, Wash.

Step Sequencing

the new **Eagle Step Switch**

use any type of time or sensing device to advance the *Eagle Step Switch*



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INTERVAL TIMER

PRESSURE CHANGE

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operate a multiplicity of load circuits in any combination up to 19 circuits

This new Eagle Step Switch also provides:

1 SEQUENCING INTERLOCK when used with multiple indexing circuits.

2 10 AMP SWITCH CONTACTS control load switches direct — no need for load relays.

3 MECHANICAL CIRCUIT INTERLOCK by cam action — eliminates interlocking relays.

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Please send Bulletin 780 containing complete data on your new Eagle Step Switch.

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CITY ZONE STATE

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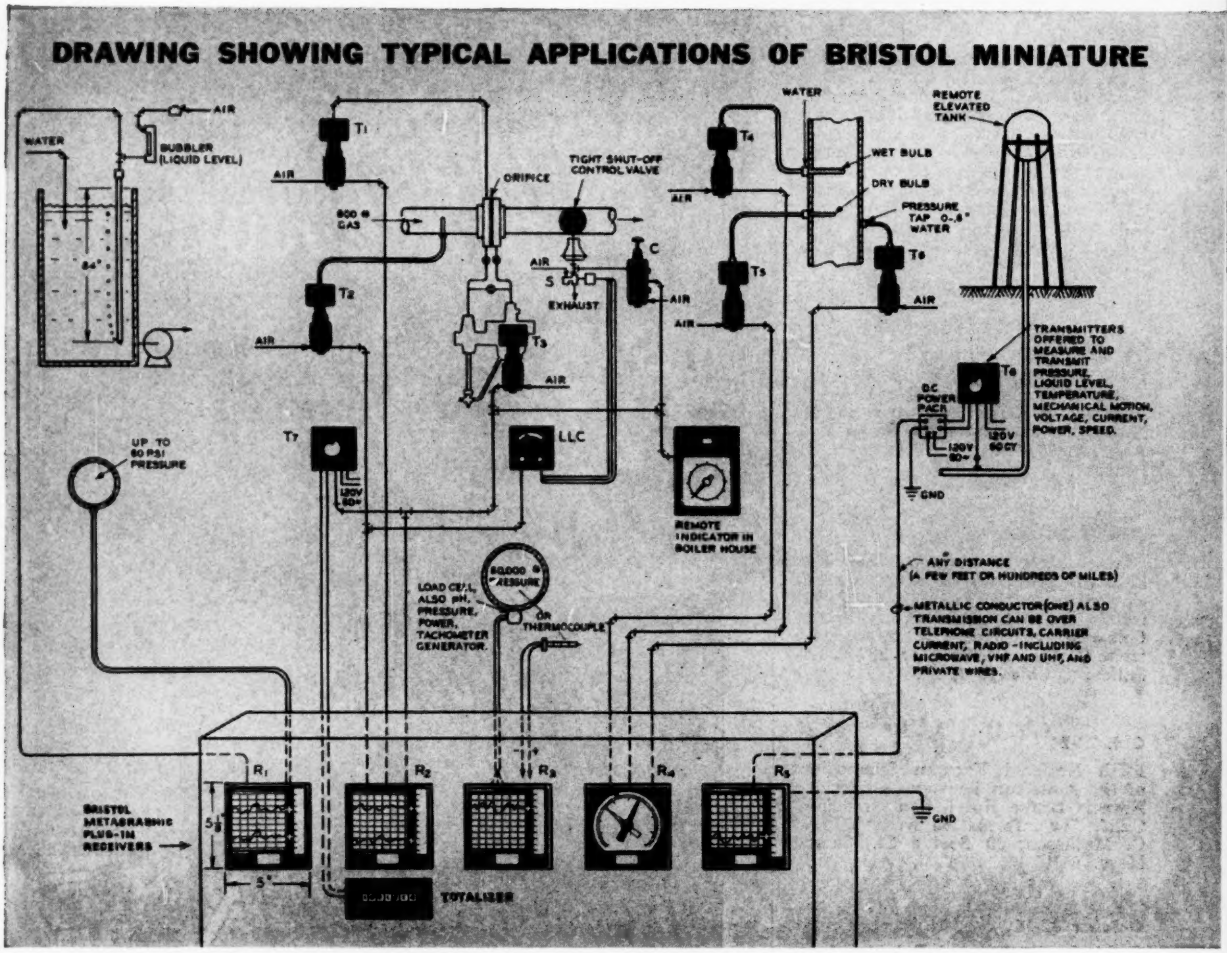
DRAWING SHOWING TYPICAL APPLICATIONS OF BRISTOL MINIATURE
WATER
AIR
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ORIFICE
TIGHT SHUT-OFF CONTROL VALVE
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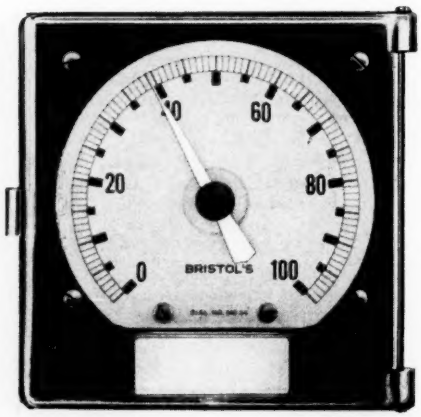
THERMOCOUPLE
BRISTOL METAGRAPHIC PLUG-IN RECEIVERS
TOTALIZER

ALL RECEIVERS LOOK ALIKE ON GRAPHIC PANEL, and all take the same panel cutout (4 9/16" sq.)

Bristol offers: **More types of miniatures**



BRISTOL METAGRAPHIC INDICATORS feature easy-to-read 9-inch effective length scale and interchangeability with recorders of same type.

Bristol Miniature Instrument Systems offer broadest measurement range and widest process control coverage:

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- ***Recording Gauges***

Automatically Controlling, Recording, and Indicating Models

"See our complete line of instruments in Booths 1217 through 1225 at the ISA Show"

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INSTRUMENT SYSTEMS

LEGEND

BRISTOL* METAGRAPHIC TRANSMITTERS

T_1 Pressure
T_2 Temperature
T_3 Differential Pressure or Flow
T_4 Temperature (Wet Bulb)
T_5 Temperature (Dry Bulb)
T_6 Pressure (as low as 0 to 5 mm mercury)
T_7 Integrator
T_8 Liquid Level Metameter Telemeter

*Metagraphic Transmitters are available for temperature, pressure, vacuum, differential pressure, flow, liquid level, mechanical motion, and through the use of the Bristol Dynamaster† Electronic Transmitter any input signal in the form of voltage, current, or change of resistance, capacitance, or inductance such as pH, speed, strain, density, etc.

BRISTOL RECEIVERS

R_1 Pressure or/and Liquid Level Recorder
R_2 Metagraphic Recorder (up to 2 records and 1 indicator)
R_3 Dynamaster Electronic Potentiometer or Bridge
R_4 Metagraphic Indicator—one, two, or three pointers for wide range of measurements or two pointers and one manual remote control.
R_5 Metameter† Telemeter

†T.M. Reg. U.S. Pat. Off.

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(36 models to choose from—by far widest variety available)

Five Modes of Control

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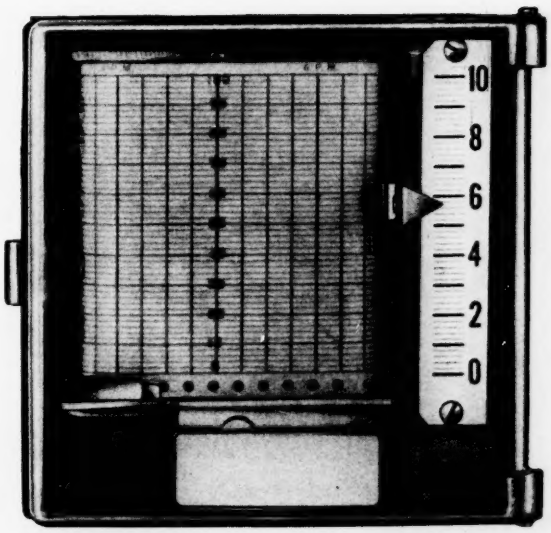
2. Proportional (Adjustable Gain)
3. Proportional-plus-Reset
4. Fixed-Proportional plus Fast-Reset
5. Proportional-plus-Reset-plus Derivative



BRISTOL METAGRAPHIC MINIATURE RECORDERS —whether electronic, pneumatic, telemetering, or gauge types—present a uniform, pleasing easy-to-read panel appearance, measure only 5″ x 5 1/8″, fit same 4 9/16″ square panel cutout.

than any other instrument company

. . . plus a complete line of full-sized instruments

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Planned to give graphic panel installations a neat, pleasing, matching appearance.

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Planned to give you any type of instrumentation electronic, pneumatic or mixed systems in plug-in miniature construction.

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AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

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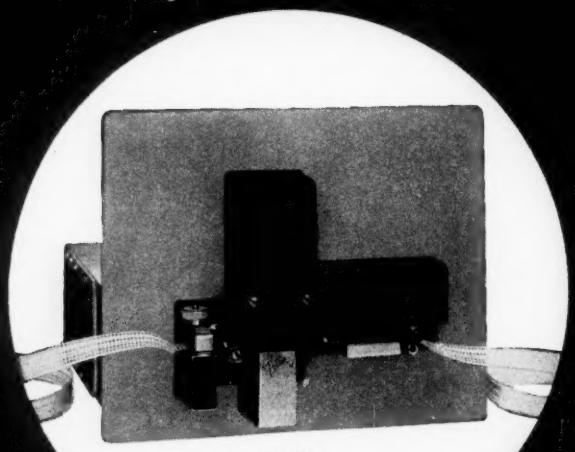

THE
NEW POTTER "909"

Now... a device that READS and STOPS faster, better

The compact '909' Perforated Tape Strip Reader now makes it possible to process information from perforated tape into digital data computer systems at high speed and low cost. Simple to operate by clerical personnel, the '909' is completely transistorized, and will give maximum performance with complete reliability.

The '909' is a compact unit, suitable for console or rack mounting. Here are some of the performance features, available for the first time in equipment of this type:

- Character reading speeds up to 1000 char/sec.
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- Reads 5, 6, 7 or 8 level tape with sprocket channel
- Ambient temperature up to 125° F. with 10,000 hour life
- Built to meet requirements of MIL-E-4158A

Specifications

Tape Speed:
10 to 100 ips

Tape Width:
Any Standard Width

Power Requirements:
115V, 60 Cycle, 1 Phase

Control:
Remote/Level Inputs

Contact your Potter representative or call or write direct for further information.

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The mark of Engineering Quality

Potter has career opportunities for qualified engineers who like a challenge, and the freedom to meet it.

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BOOK Reviews

Basics of Digital Computers, John S. Murphy, 1958. Vol. 1 (No. 196-1), Vol. 2 (No. 196-2), and Vol. 3 (No. 196-3), John F. Rider Inc., New York, N. Y., 6″ x 9″, soft cover, $2.50 each, or 3-volume set $6.95. All three volumes in single cloth binding $7.95, 416 pages. "Picture-book" course facilitates mastery of basics of digital computers for anyone with knowledge of fundamentals of electronics. Volume one reviews developments of computers, then explains theory of computer arithmetic, data representation, program, AND and OR circuitry, etc. Volume two discusses the logical elements, circuits, etc. and shows some encoders, decoders, counters, etc. Volume three handles memory types, control systems, and input-output equipment.

Principles and Practice of Flow Meter Engineering, L.K. Spink, 549 pages, eighth edition, revised and enlarged, 1958, The Foxboro Company, Foxboro, Mass., 6″ x 9″, hard-bound, $15. Primarily a text book, covers much broader scope than earlier editions. Uses AGA and ASME terminology with all tables, curves, factors, etc., based on AGA Report Number 3. Covers equipments and flow calculations for liquids, steam, vapors, and gas.

Automatic Control, Principles and Practice, Werner G. Holzbock, 1958, Reinhold Publishing Corp., New York, N. Y., 6″ x 9″, hard-bound, $7.50. Covers, in non-mathematical terms, dynamic behavior of control systems; mechanical and electrical components—measuring elements, controllers, and control valves; control systems and their applications; and servos.

Automatic Process Control, by Donald P. Eckman. [c1958.] John Wiley & Sons, New York 16, N. Y. 368p. $9. 9 in. Emphasizes block diagrams and closed-loop systems. Primarily for engineering students. Presupposes knowledge of calculus, differential equations, and thermodynamics.

Control Engineers' Handbook, edited by John G. Truxal. 1958. Mc-

Graw-Hill Book Co., New York 36, N.Y. various paging. $18.50. 9¼ in. Includes contributions by 36 authors most of whom are in industry though some are in universities. Intended for the control engineer, regardless of his primary field of interest. Deals with *components* of control systems rather than design of systems.

Electronic Measuring Instruments. Ed.2 by E.H.W. Banner. [c1958.] Macmillan Co., New York 11, N.Y. 496p. $7.95. 8½ in. Revision with more than 100 pages added. For designers and users of instruments and for the advanced student.

Process Instruments and Controls Handbook, edited by Douglas M. Considine. 1957. McGraw-Hill Book Co., New York 36, N.Y. [1286p.] $19.50. 9¼ in. A rather comprehensive treatment of instrumentation and automatic control. Articles by more than seventy contributors.

Van Nostrand's Scientific Encyclopedia. Ed. 3. [c1958.] D. Van Nostrand Co., Princeton, N. J. 1839p. $26.85. 11¼ in. Concise treatment, with wide coverage of topics in pure and applied science. Adequately illustrated, and well supplied with cross-references.

Preparation of Programs for an Electronic Digital Computer. Ed.2. by Maurice V. Wilkes, David J. Wheeler and Stanley Gill. [c1957.] Addison-Wesley Publishing Co., Reading, Mass. 238p. $7.50. Originally concerned with the EDSAC machine, but this second edition has been expanded to afford a general introduction to programming for any computer of the stored-program type.

Industrial Electronics Handbook, by R. Kretzmann. (1957.) Philosophical Library, New York 16, N. Y. 298p. $12. 9 in. Purpose is to indicate the wide field of application of electron devices in industry, and to discuss the principles upon which typical equipment operates. Valuable in the supervision and maintenance of industrial apparatus, and in indicating the possibilities of electronic control and the methods of application.

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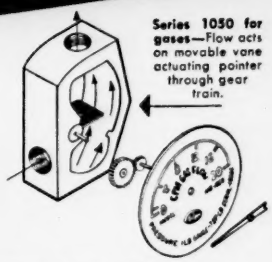
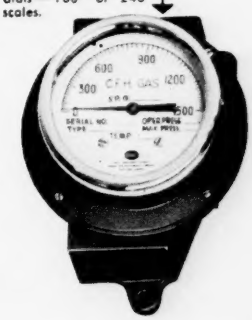
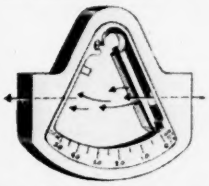
Standard Series "L" flowmeters available for pressures to 2,000 psi and flows to 6,000 gph for liquids, and 60,000 cfh for gases.



Series 1050 for gases—Flow acts on movable vane actuating pointer through gear train.

Standard Series 1050 flowmeters available to 60,000 cfh. 4½" or 6" dials—180° or 240° scales.





Series "L" for liquids — Flow acts upon movable vane which serves as pointer in instruments with transparent covers; permitting easy, visual inspection of flow. In instruments with metal covers, for higher pressures, movable vane controls magnetically coupled pointer.

Seico® INDICATING FLOWMETERS offer you these advantages:

Accurate, easy-to-read, pointer-type indicating instruments. A small pressure drop across the meter provides sufficient power for operation. This unique and exclusive basic design principle offers you the following:

Not position-conscious—Can be mounted in horizontal or vertical lines. (Series "L"). (1050 Series mount vertically)

Hermetically sealed—A protection against leakage of toxic, corrosive, or flammable liquids or gases.

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Complete information on this outstanding line of accurate, dependable indicating flowmeters is available in Bulletin V-100. Use convenient coupon to secure copy.

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Model 1012 Visicorder

Time lines (every 10th line accented)

this is a double

1012 Recorder

Trace identification

Longitudinal grid lines (every 5th line accented)

Record numbering

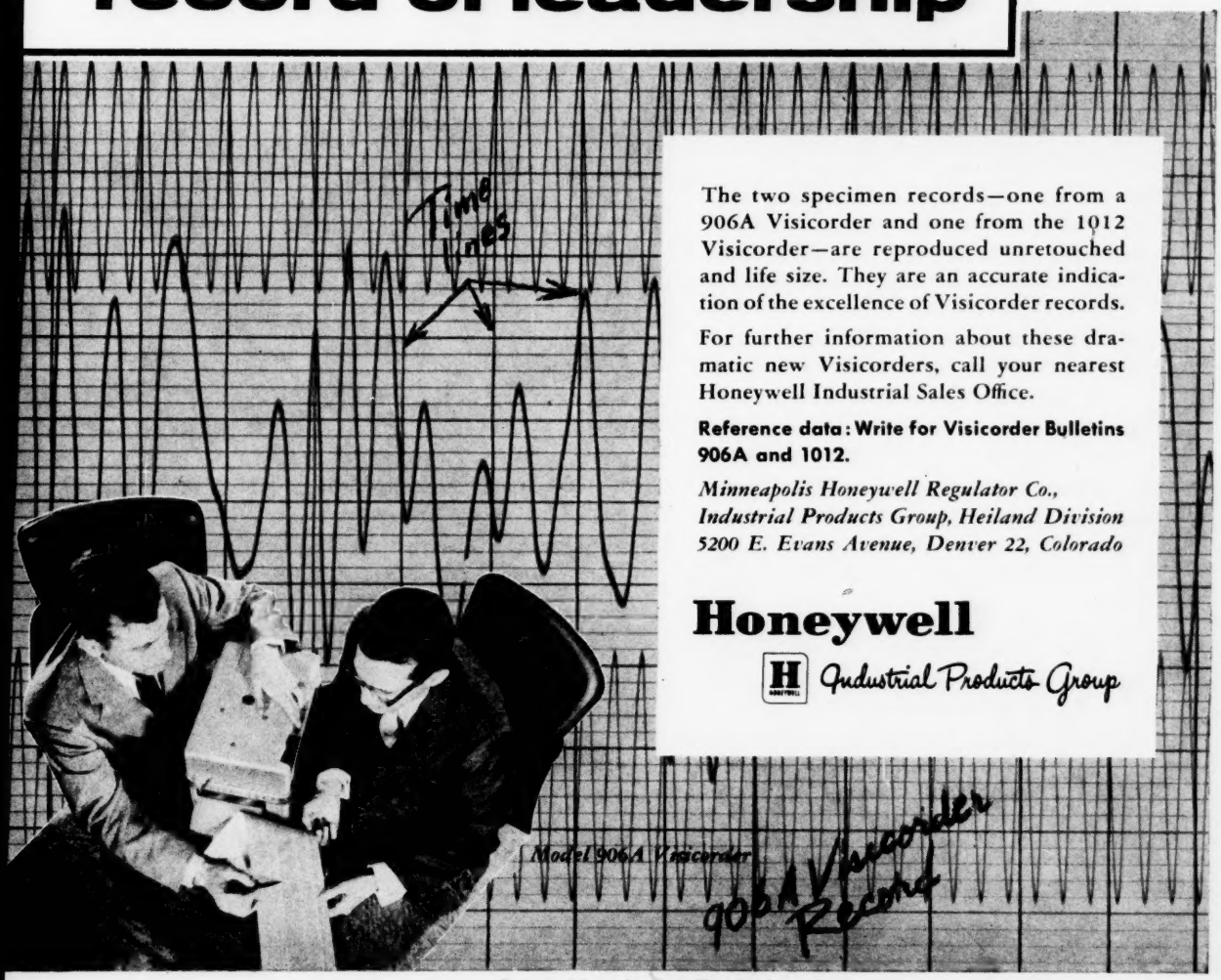
10-249

When the Honeywell Model 906 Visicorder was introduced as the first practical high-frequency direct-writing oscillograph in history, it met with instant success.

Now the new Honeywell Model 1012 Visicorder extends the range and usefulness of the exclusive Visicorder principle. It is a highly sensitive 36 channel instrument with frequencies from DC to 3000 cps. Its exclusive features are many . . . it is the most convenient, foolproof, reliable, broad-capacity oscillograph on the market today.

And the 906 Visicorder is now available in two new models: the 906A-1 with 14 channels, and the 906A-2 with 8 channels. An accurate time-line system and a simultaneous grid-line recording system are optional in both 906A Models. Both oscillographs are producing superior, clear, reproducible, accurate, high sensitivity, high frequency direct recordings in many varied applications every day.

record of leadership



The two specimen records—one from a 906A Visicorder and one from the 1012 Visicorder—are reproduced unretouched and life size. They are an accurate indication of the excellence of Visicorder records.

For further information about these dramatic new Visicorders, call your nearest Honeywell Industrial Sales Office.

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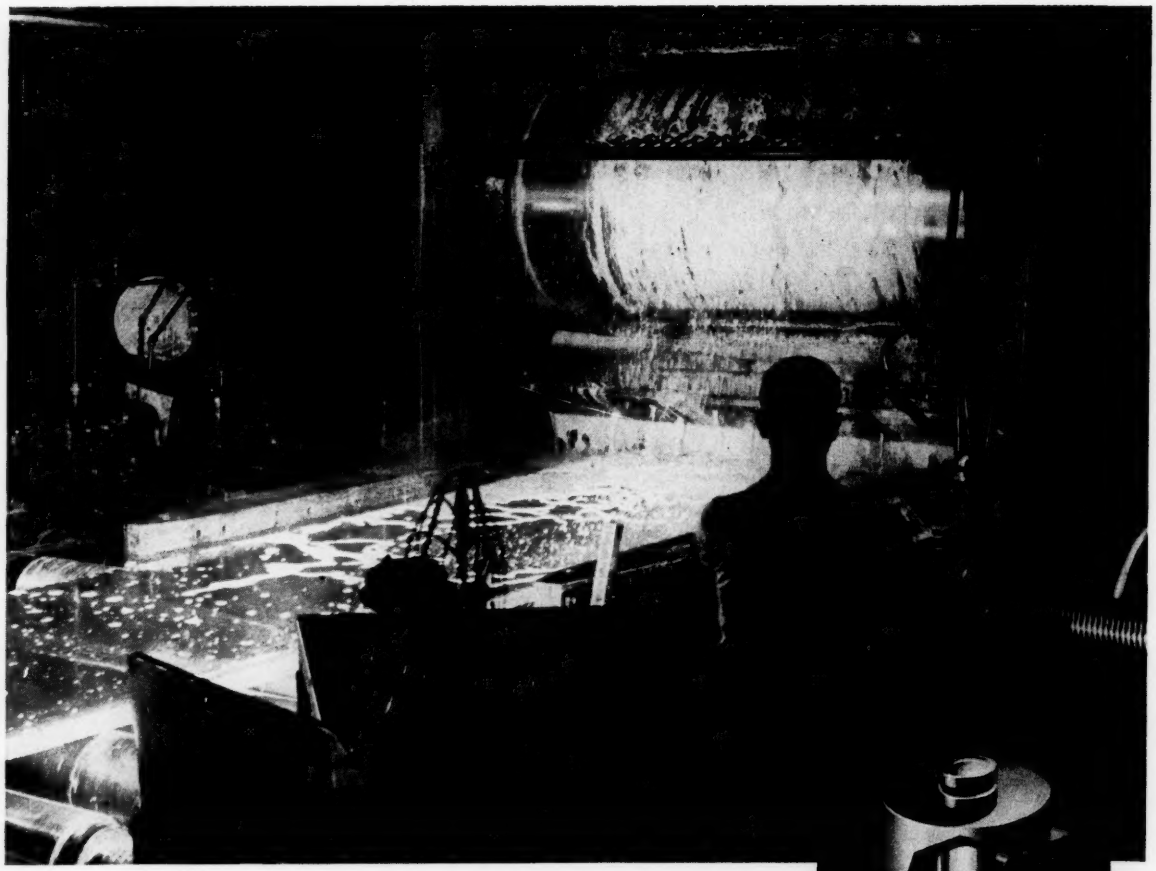

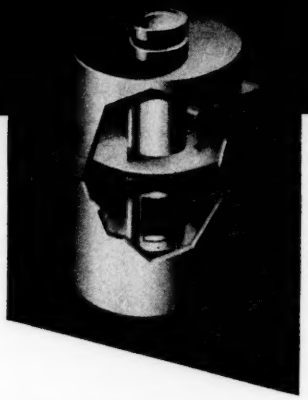

A giant "squeeze"—measured and controlled by B-L-H Load Cells

Despite the tremendous forces unleashed in a rolling mill operation, the actual pressure exerted by the giant rollers can be measured with high precision by built-in B-L-H SR-4® Load Cells. These electronic transducers give the operator exact load readings, enabling him to roll sheets to just the proper thickness every time.

B-L-H transducers will measure any forces involving tension, compression, torque, etc. With appropriate instrumentation, they can also determine center of gravity, weigh loads at rest or in motion, control batch and continuous processes, and record all data required. Long-term accuracy is within ±1/10%, repeatability within ±1/20%. The type and number of applications are virtually unlimited.

SR-4® Load Cells have capacities ranging from 50 to 200,000 lb. Loads on the cells are converted to proportional voltage—permit the instruments for reading or recording changes to be located at any remote point.

For more information on these precision load cells, have us send one of our field men around to see you, without obligation. And write to Dept. **7-H** for a copy of Bulletin 4302.

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SR-4® strain gages • Transducers • Testing machines

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ALL-ELECTRONIC DIGITAL VOLTMETER...ONLY $960

MEASURE
MILLIVOLT TO
KILOVOLT WITH
0.1% ACCURACY

Here at last is a portable all-electronic digital voltmeter that measures DC voltages from .001 to 1000 volts with 0.1% accuracy. In less than 1/10 of a second the measured voltage is presented in clear numerical form on a digital in-line readout that even unskilled personnel can read quickly and accurately, with little possibility of error. *Direct* voltage measurement by successive approximation provides accuracy and sensitivity previously obtainable only in the delicate, complex and expensive instruments. Extremely stable operation – continuous calibration against an internal reference.

The low price of the Model 801 allows you to put one on every bench. Its accuracy and reliability are assured by KIN TEL's years of design and manufacturing experience ... experience gained in the manufacture of more than 10,000 precision electronic instruments.

BRIEF SPECIFICATIONS (model 801)

Ranges.....0.000 to 1.599; 00.00 to 15.99; 000.0 to 159.9; 0000. to 1000 volts (manual ranging and polarity)
Accuracy.....0.1% of full scale
Readout.....4 digits plus decimal point
Input Impedance.....20,000 ohms per volt*
Conversion Rate.....10 per second
Conversion Time.....approximately 70 milliseconds
Display Time.....Adjustable from approximately .1 second to infinity (plus push-button *read once* control)
Dimensions.....11" high x 7½" wide x 20" deep
Power Requirements.....105 to 125 volts, 60 cycle AC, 180 watts

*The Model 802 provides 10 megohms input impedance. Price $1190. In other special models the binary coded decimal and decimal outputs are externally available to permit use as an analog to digital converter.

5725 Kearny Villa Road, San Diego 11, California. Phone BRowning 7-6700

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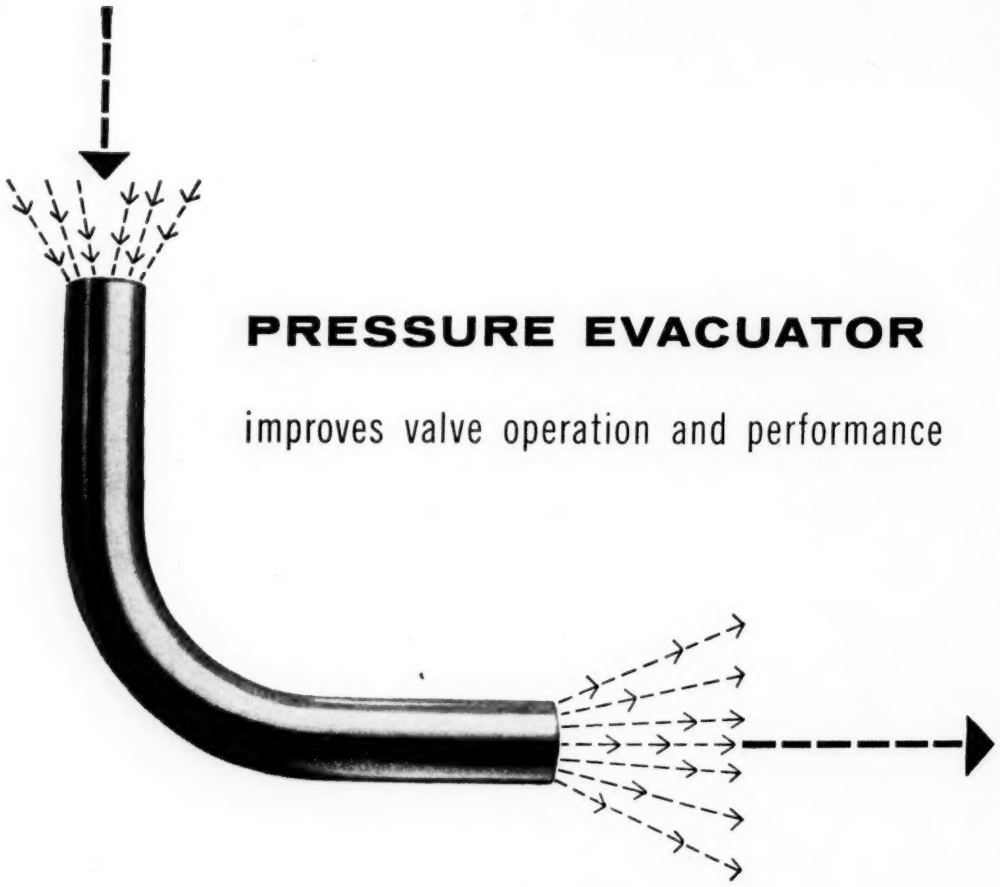
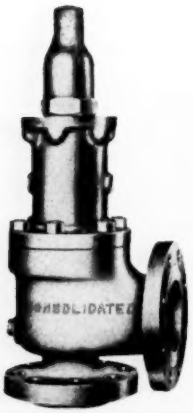


PRESSURE EVACUATOR

improves valve operation and performance



Consolidated Safety Relief Valve, Type 1900 Series, Sizes: 1" x 2" to 8" x 10".

The Eductor Tube in Standard Consolidated Safety Relief Valves is a pressure evacuator. It efficiently removes pressure from the closed bonnet. If allowed to remain in the bonnet, the pressure would act on the top of the disc and tend to limit the lift and induce cycling. But with the pressure evacuated from the closed bonnet through the Eductor Tube, the spring alone controls valve action. Consequently, *reliable* valve action and guaranteed capacity ratings are attained. A new high in operational dependability is assured.

Reliable operation and performance of Consolidated Safety Relief Valves are your assurance of absolute protection for personnel and equipment. "2 in 1" design permits you to convert the Standard valve to the Bellows type in your own shop. But that is only part of the total economy of these modern valves. Get the complete inside story. Write for Catalog 1900.

MANNING MAXWELL & MOORE INC. TRADE MARK

T2-58

CONSOLIDATED SAFETY RELIEF VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Tulsa, Oklahoma

In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

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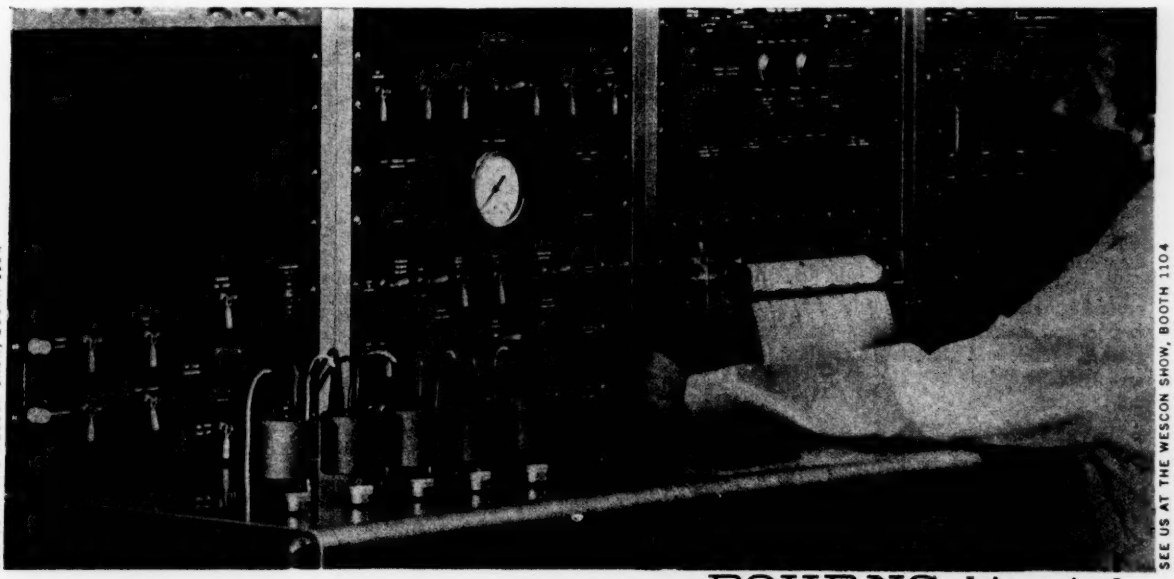
BOURNS

BOURNS FINGERPRINTS EACH PRESSURE TRANSDUCER

With every Bourns pressure transducer, you get a "fingerprint" report, a 100% profile of each instrument. Dynamic calibration, hysteresis error, resolution—are plotted for you. The Bourns-designed DYNAPAC® (dynamic precision analog comparator) records pressure transducer performance continuously, measures total response in voltage ratio, and indicates go-no-go on insulation resistance. In other words, DYNAPAC plots a technical "fingerprint"—complete documentary proof of the reliability and individual performance of each pressure transducer. And you get the report.

DYNAPAC is typical of the manufacturing and test equipment used by Bourns to assure you that *all* Bourns products exceed the high reliability requirements of today's electronic systems. If you would like more technical information on DYNAPAC, or a copy of our Instrument Model Summary Brochure, write BOURNS LABORATORIES, INC., P.O. Box 2112G, Riverside, California • Or contact a Bourns Field Office: 21 Walt Whitman Road, Huntington Station, L.I., New York • 4515 Prentice St., Dallas 6, Texas • Exclusive manufacturers of TRIMPOT® and TRIMIT®, and Pioneers in Potentiometer Transducers for Position, Pressure and Acceleration.



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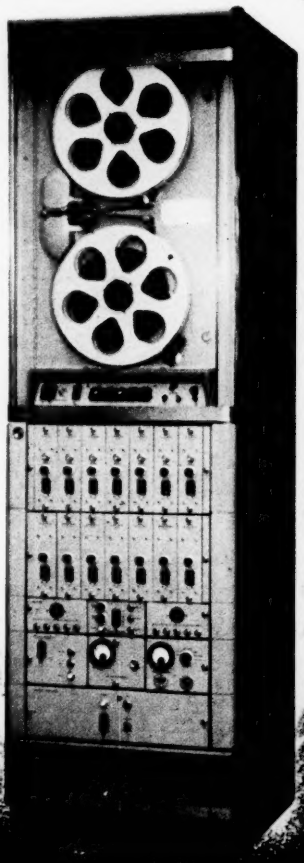
90% of all U.S. long-range missile test flights are recorded on CEC



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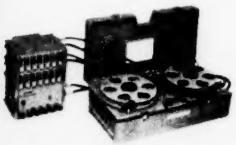
from 0 cps

DataTape

ADJUSTABLE TAPE LOOP ATTACHMENT
Permits fast, inexpensive conversion of the 5-752 into a continuous loop transport for repetitive playback and data analysis.

DIGITAL MAGNETIC-TAPE RECORDER/ REPRODUCER

5-781 MAGNETIC-TAPE RECORDER/ REPRODUCER (continuous loop)



AIRBORNE DATATAPE SYSTEM

Scientists and engineers depend on CEC for equipment of proved versatility . . . precision . . . reliability. They look to CEC for solutions to data-recording problems—and find them in CEC's 5-752 Recorder/ Reproducer System.

The 5-752 delivers instantaneous playback of up to 14 tape tracks with simultaneous recording or reproducing of separate signals. Quickly adaptable to use 1-mil base high-strength Mylar instrumentation tape, allowing 50% more tape footage per reel. Seven different types of plug-in amplifiers record and reproduce in Analog, PDM or FM modes.

The military and industry alike use the 5-752 in recording telemetered missile data, wind-tunnel testing, jet and rocket engine testing, shock and vibration studies, mobile and stationary structural testing, static and dynamic testing, sound measurements, and medical research.

Two exclusive design advances distinguish the 5-752 as a leader in the field of data recording and reproducing:

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The all-metal-surface of CEC's magnetic heads promotes a self-cleaning action and minimizes head wear. Oxide can't build up on heads to cause drop-outs or loss of high-frequency response.

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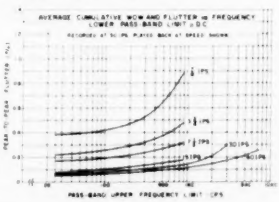
At tape speeds of 1⅞ and 3¾ ips, cumulative flutter in the 5-752 is about 50% less than the flutter found in other tape equipment. Accompanying chart shows flutter recorded at 30 ips and played back at speeds indicated.



For complete information, contact your nearest CEC sales and service office, or write for Bulletin CEC 1576-X27.

DataTape Division

Consolidated Electrodynamics

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OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

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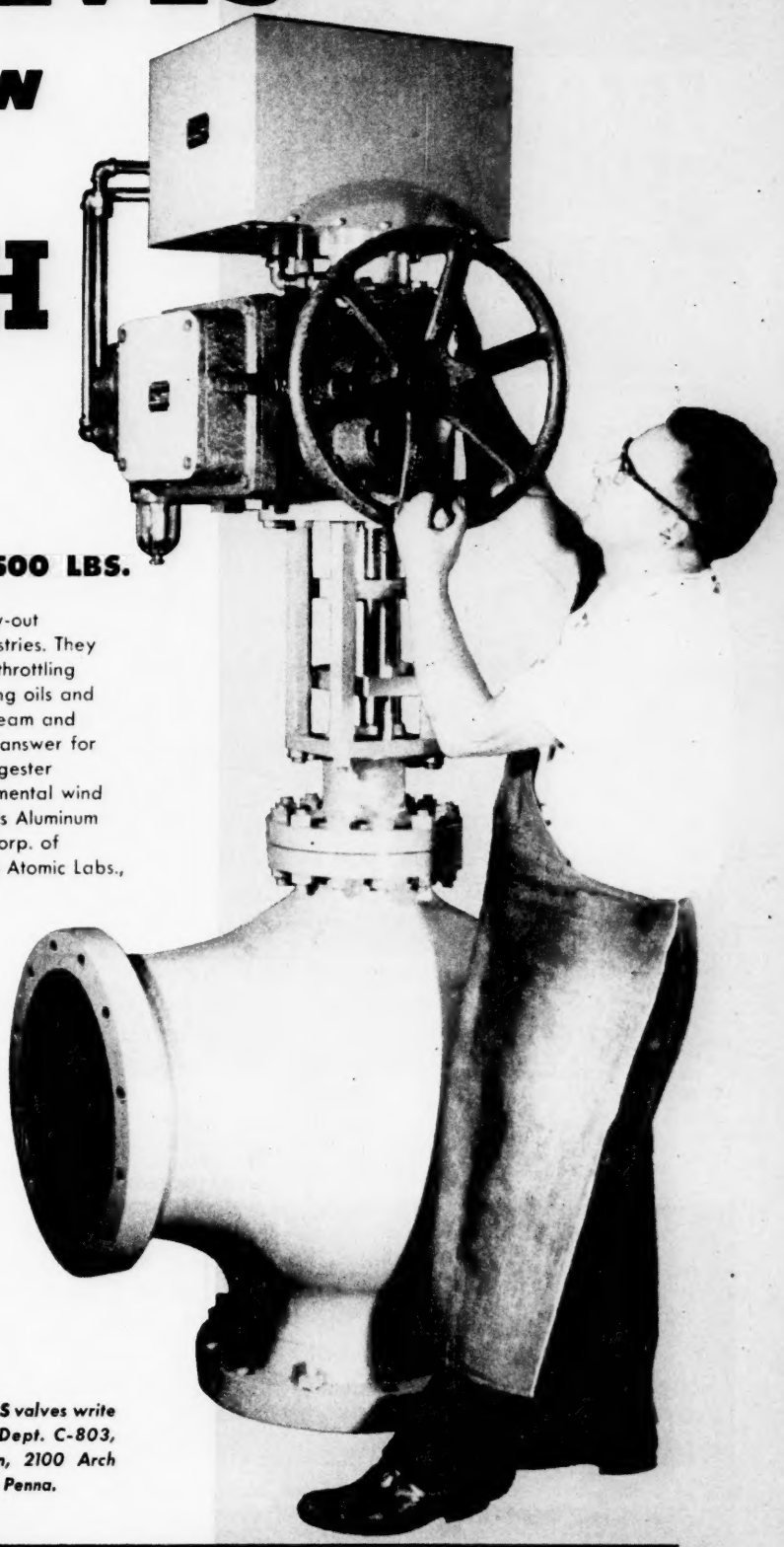
S VALVES

by CONOFLOW

for the

TOUGH

JOBS



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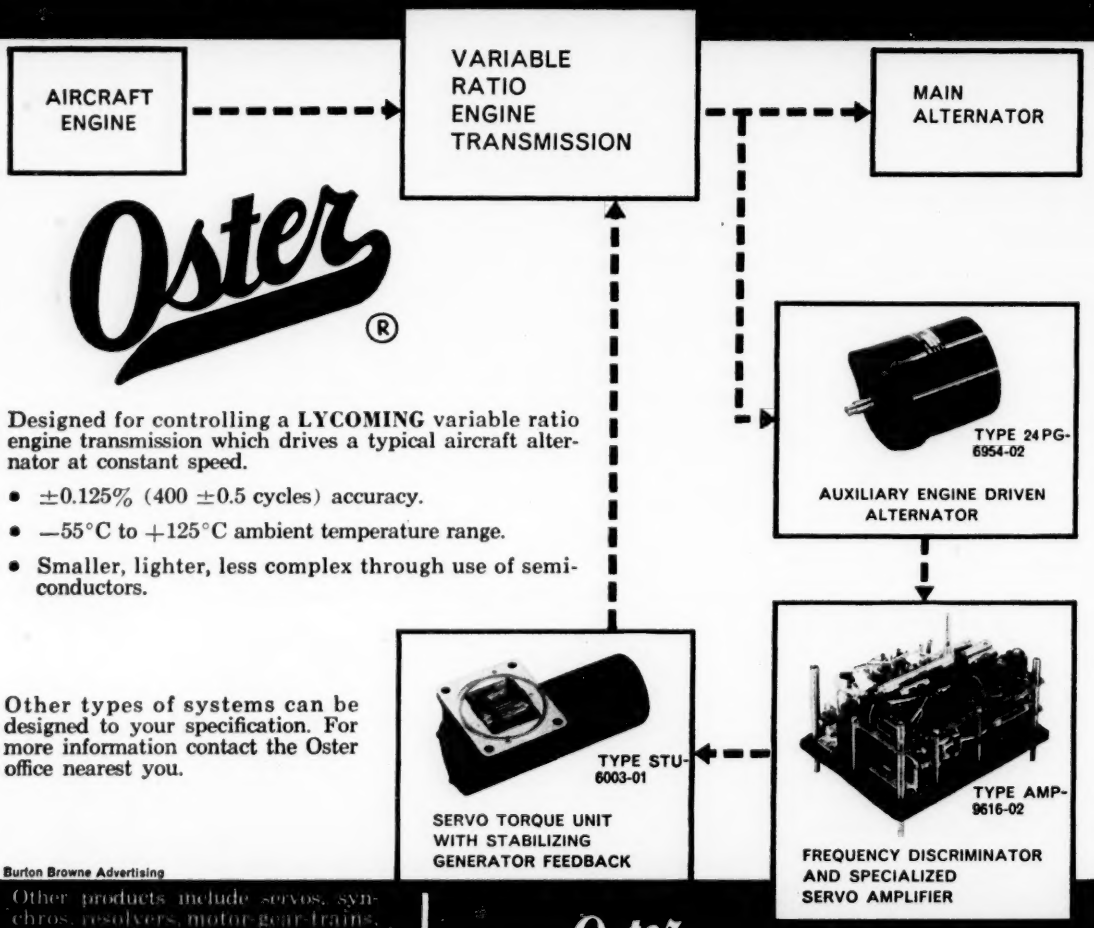

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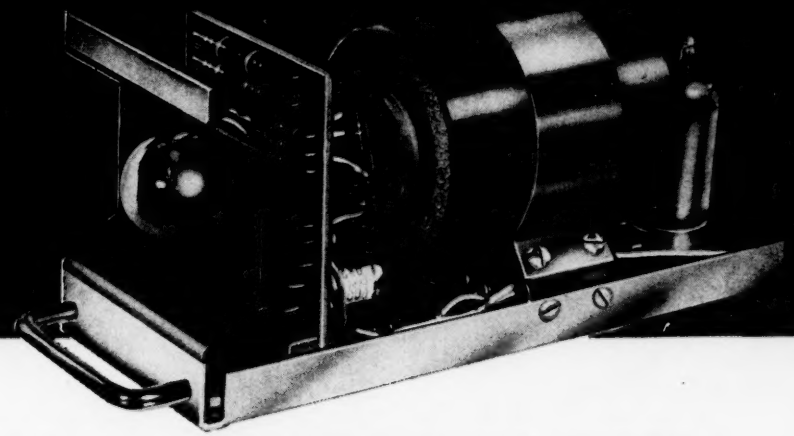

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Input	Negative 2.5 μs 125V ½ Sine Wave Or Output of DC-101 DC-102	Negative 50 Volts Less than 1 μsec rise time Duration at least 2 μsec	Negative 110 Volts Less than 0.5 μsec rise time	Negative 110 Volts Less than 0.5 μsec rise time
Output	Drive DC-101	Drive DC-101	Drive DC-102	Drive DC-105 and 10 Individual Outputs
Resolution of Paired Pulses	Less than 10 μsec	Less than 10 μsec	Less than 1 μsec	Less than 1 μsec
Reset to Zero	Manual on Switch Closure or Electronic with Suitable Pulse	Manual on Switch Closure or Electronic with Suitable Pulse	Manual on Switch Closure or Electronic with Suitable Pulse	Manual on Switch Closure or Electronic with Suitable Pulse
Construction	Plug-In-Winchester Type MRE9P For Insertion in Type MRE9S	Plug-In-Winchester Type MRE9P For Insertion in Type MRE9S	Plug-In Winchester Type MRE9P For Insertion in Type MRE9S	Plug-In Printed Circuit Board For Insertion in U. S. Components UPCR93-D10
Maximum Counting Rate	10 KC	100 KC	1 Mc	1 Mc
Count Indication	Nixie "in-line" Numerical Readout — Type 6844A	Nixie "in-line" Numerical Readout — Type 6844A	Nixie "in-line" Numerical Readout — Type 6844A	Nixie "in-line" Numerical Readout — Type 6844A
Power Requirements	300 V — 18 ma DC 6.3 V — 0.3 A AC	300 V — 28 ma DC 6.3 V — 0.6 A AC	300 V — 30 ma DC 6.3 V — 0.9 A AC	300 V — 30 ma DC 6.3 V — 0.9 A AC
Tube Complement	Type BD300 Beam Switching Tube Counter — 6844A Indicator	Type BD300 Beam Switching Tube Counter — 6844A Indicator — Type 6201 Flip-Flop	Type BD300 Beam Switching Tube 6844A Indicator 5670 Flip-Flop 5963 Buffer	Type BD300 Beam Switching Tube 6844A Indicator 5670 Flip-Flop 5963 Buffer

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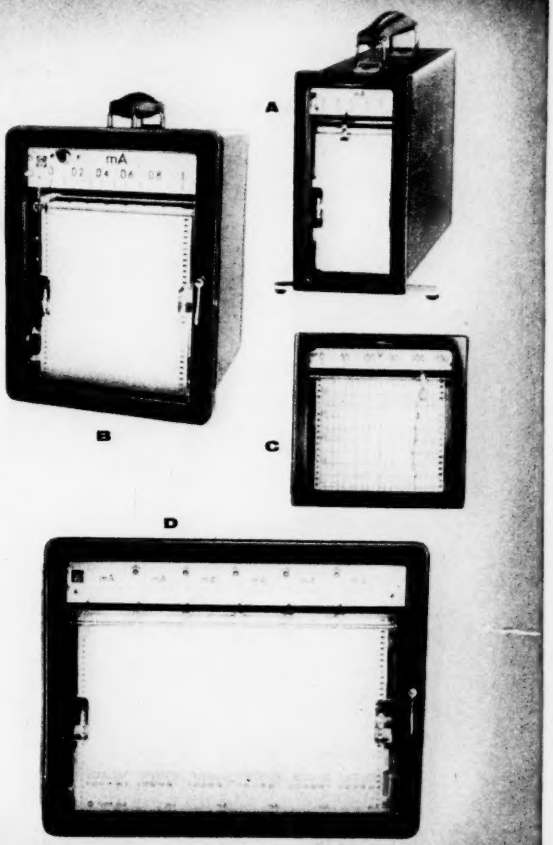
12 BIG ADVANTAGES



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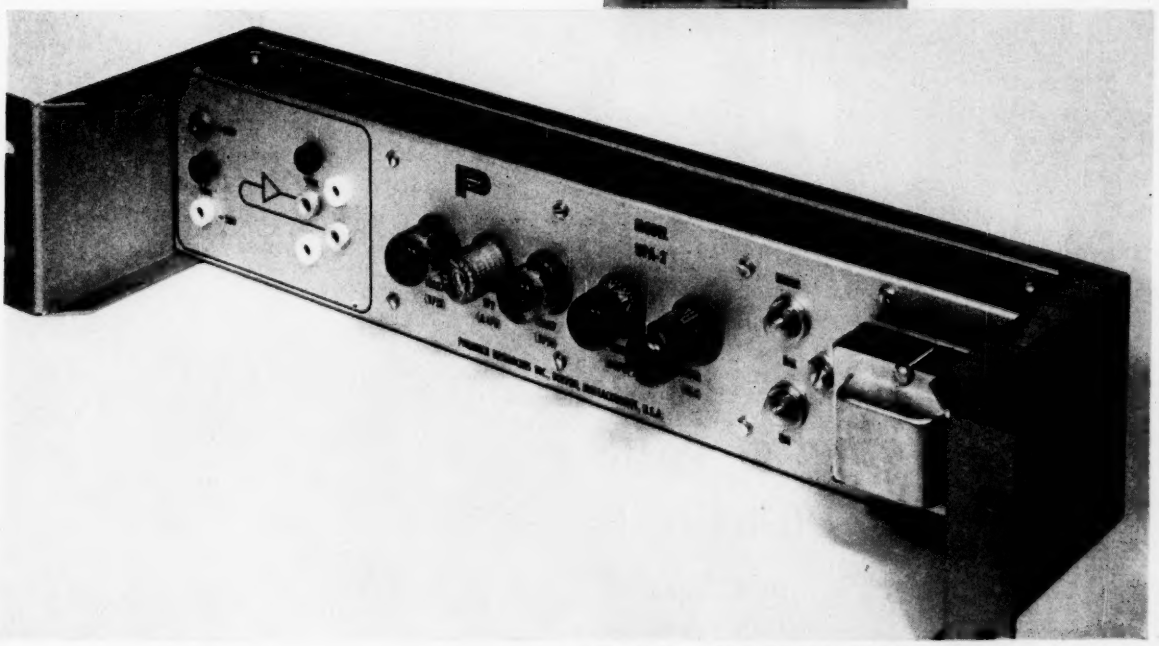

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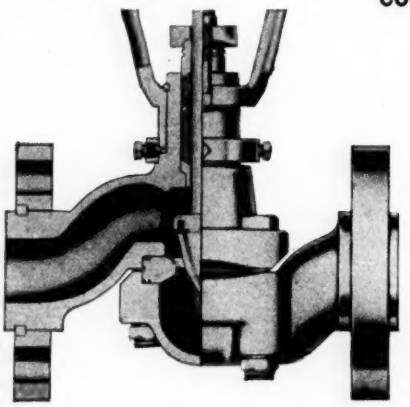
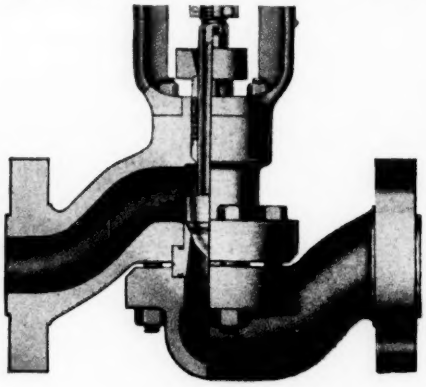
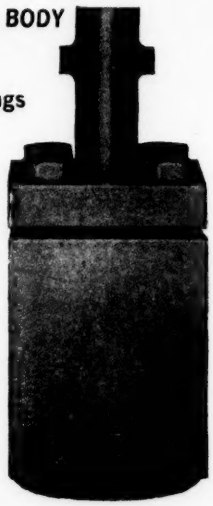


CONTROL VALVE BODY 900 and 1500 lb ASA ratings



MOLTEN METAL VALVE BODY



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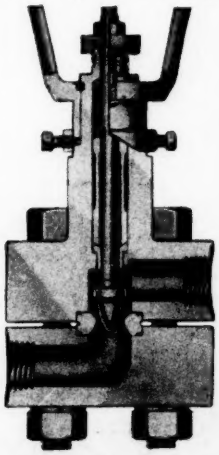

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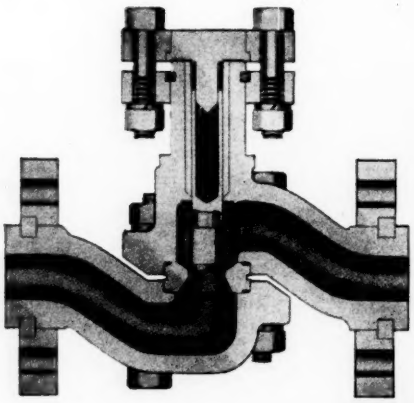
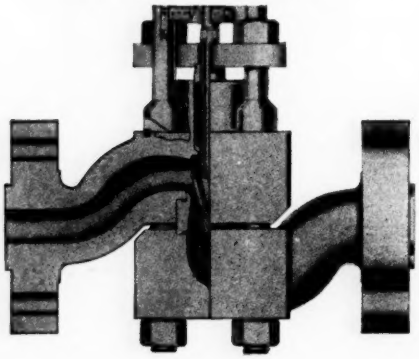


CONTROL VALVE BODY
2500 and 10,000 lb ratings



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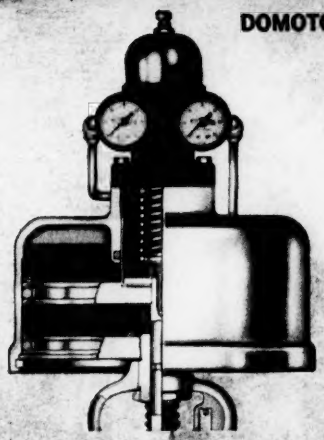

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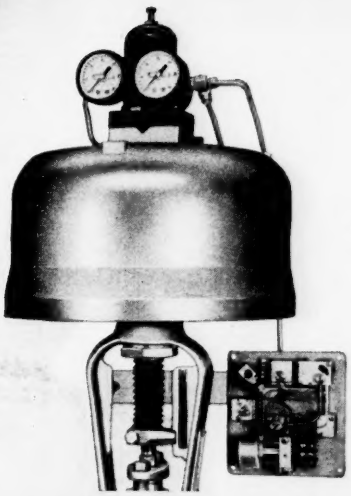
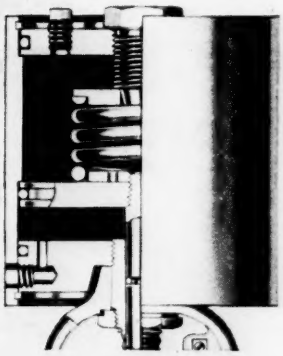


ELECTRO-PNEUMATIC DOMOTOR OPERATOR

ANNIN VALVE BODIES AND OPERATORS



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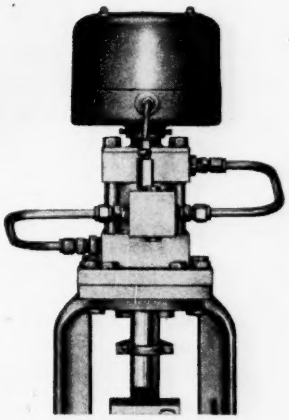
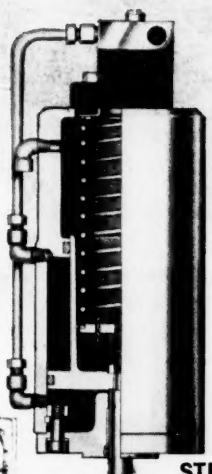


ELECTRO-HYDRAULIC OPERATOR



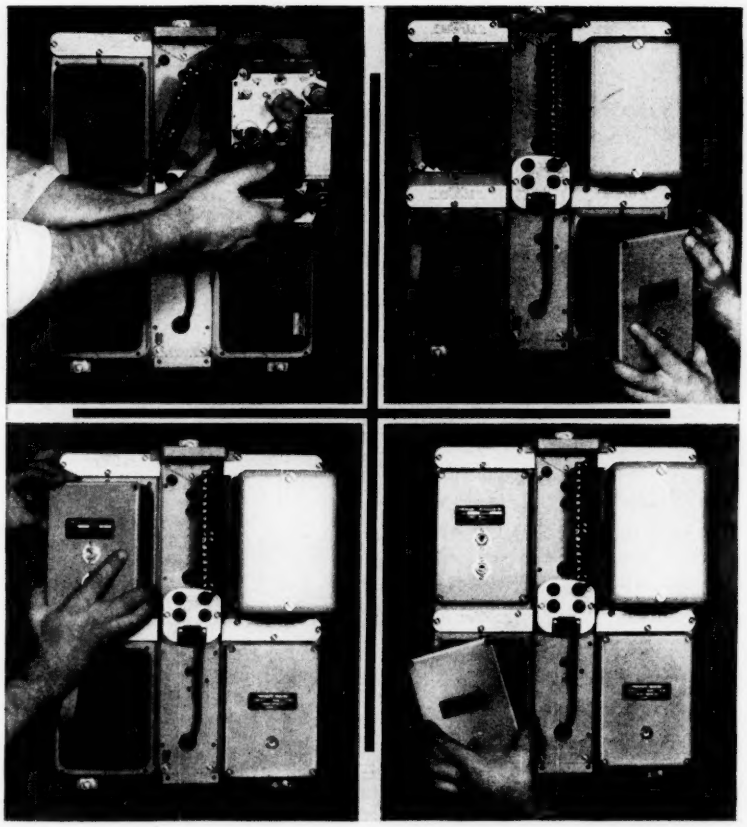
STROKE POSITIONING OPERATOR

COMPANY

DIVISION OF THE ANNIN CORPORATION

AUTOMATION CONFERENCE AND EXHIBIT, SEPTEMBER 15-19, PHILADELPHIA, PA.

CUSTOM BUILD your own Bailey Recorder



These four views of the back of a Bailey Recorder show how four plug-in units may be added as needed to meet almost any recorder application.

The freedom and flexibility of "do-it-yourself" instrumentation is yours in the Bailey Recorder. A variety of plug-in units make it possible to record, control, and retransmit any variable that can be converted to a pneumatic or electric signal.

The basic plug-in units are the Bailey a-c and d-c Electronic Receivers and Pneumatic Receivers. Any four of these may be used in one recorder, intermixed in any way, to provide four continuous records on one chart.

For automatic control, other plug-in units are available.

For square root extraction or linear integration, there are two plug-in variations of the Bailey Integrator.

When you want a pneumatic signal that varies according to a pre-set pattern plug in a Bailey Program Controller.

Periodic running time of a condition or process is recorded on the chart when a Bailey Running Time Recorder is used.

These and other plug-in units are described in Product Specification E12-5. Some companies stock Bailey Recorder cases and assorted plug-in units. As instrumentation and control needs arise they build up the kind of recorder-controller required, using the proper plug-in units from stock. Unmatched versatility such as this means lower instrumentation costs.

For the complete story of how easily you can custom build this recorder to your needs, see your Bailey Engineer. G43-1

BAILEY METERS

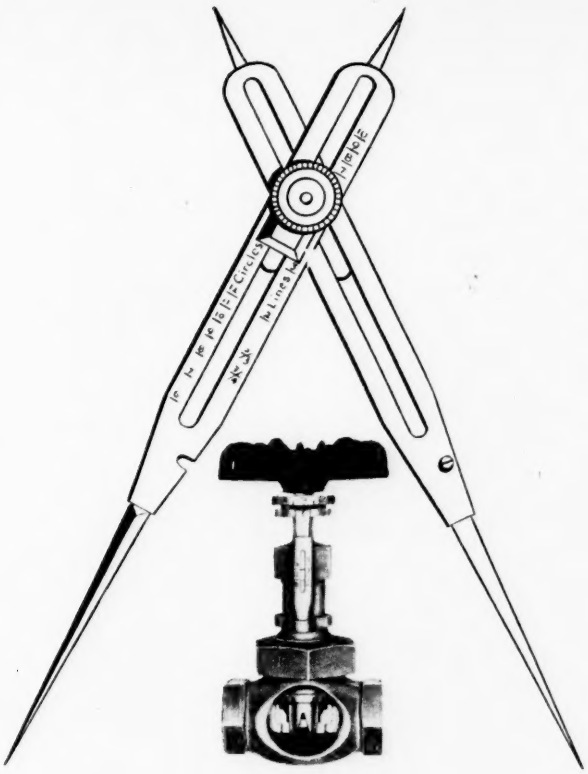
Instruments and controls for power and process

BAILEY METER COMPANY

1041 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

For more information circle **65** on inquiry card.



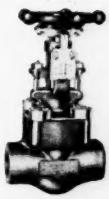
PROPORTIONER

controls flow to save for you

The V-port disc in all Hancock "Flocontrol" Valves insures proportional flow throughout the entire lift of the stem. They are valves that help you achieve uniform product quality through closer control, save steam and fuel on process work, and cut maintenance costs.

"3 in 1" valve design combines variable orifice with shut-off and micrometer dial and pointer. The valve opening can be set within 1/10 turn of the handwheel —you can duplicate all settings easily, instantly. No shut-off valve required—flow is in a straight line, with separate shut-off seating surface located away from the V-ports.

Hancock "Flocontrol" Valves are available in Bronze and Steel to meet the most demanding services. Ask your industrial supply distributor for details.



Hancock "Flocontrol" valves assure positive pinpoint control—eliminate all guesswork.

MANNING MAXWELL & MOORE INC. TRADE MARK

HI-58

HANCOCK "FLOCONTROL" VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Watertown, Massachusetts

In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

For more information circle **69** on inquiry card.

FREQUENCY STANDARDS

*3⅛" high
400 - 1000 cy.

PRECISION FORK UNIT
TYPE 50

Size 1" dia. x 3¾" H. Wght., 4 oz.*
Frequencies: 240 to 1000 cycles
Accuracies:—
Type 50 (±.02% at —65° to 85°C)
Type R50 (±.002% at 15° to 35°C)
Double triode and 5 pigtail parts required
Input, Tube heater voltage and B voltage
Output, approx. 5V into 200,000 ohms

FREQUENCY STANDARD
TYPE 50L

Size 3¾" x 4½" x 5½" High
Weight, 2 lbs.
Frequencies: 50, 60, 75 or 100 cycles
Accuracies:—
Type 50L (±.02% at —65° to 85°C)
Type R50L (±.002% at 15° to 35°C)
Output, 3V into 200,000 ohms
Input, 150 to 300V, B (6V at .6 amps.)

*3½" high
400 to 500 cy.
optional

PRECISION FORK UNIT
TYPE 2003

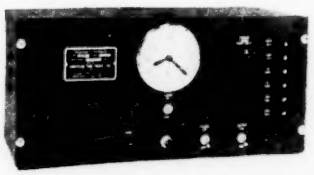
Size 1½" dia. x 4½" H. Wght. 8 oz.*
Frequencies: 200 to 4000 cycles
Accuracies:—
Type 2003 (±.02% at —65° to 85°C)
Type R2003 (±.002% at 15° to 35°C)
Type W2003 (±.005% at —65° to 85°C)
Double triode and 5 pigtail parts required
Input and output same as Type 50, above

FREQUENCY STANDARD
TYPE 2005

Size, 8" x 8" x 7¼" High
Weight, 14 lbs.
Frequencies: 50 to 400 cycles
(Specify)
Accuracy: ±.001% from 20° to 30°C
Output, 10 Watts at 115 Volts
Input, 115V. (50 to 400 cycles)

FREQUENCY STANDARD *NEW*
TYPE 2007-6
TRANSISTORIZED, Silicon Type
Size 1½" dia. x 3½" H. Wght. 7 ozs.
Frequencies: 400 — 500 or 1000 cycles
Accuracies:
2007–6 (± .02% at —50° to +85°C)
R2007–6 (±.002% at +15° to +35°C)
W2007–6 (±.005% at —65° to +125°C)
Input: 10 to 30 Volts, D. C., at 6 ma.
Output: Multitap, 75 to 100,000 ohms

FREQUENCY STANDARD
TYPE 2121A

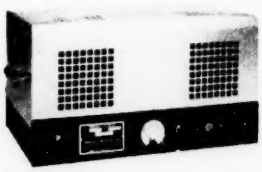


Size
8¾" x 19" panel
Weight, 25 lbs.
Output: 115V
60 cycles, 10 Watt
Accuracy:
±.001% from 20° to 30°C
Input, 115V (50 to 400 cycles)

FREQUENCY STANDARD
TYPE 2001-2

Size 3¾" x 4½" x 6" H., Wght. 26 oz.
Frequencies: 200 to 3000 cycles
Accuracy: ±.001% at 20° to 30°C
Output: 5V. at 250,000 ohms
Input: Heater voltage, 6.3 - 12 - 28
B voltage, 100 to 300 V., at 5 to 10 ma.

FREQUENCY STANDARD
TYPE 2111C



Size, with cover
10" x 17" x 9" H.
Panel model
10" x 19" x 8¾" H.
Weight, 25 lbs.
Frequencies: 50 to 1000 cycles
Accuracy: (±.002% at 15° to 35°C)
Output: 115V, 75W. Input: 115V, 50 to 75 cycles.

ACCESSORY UNITS
for TYPE 2001-2

L—For low frequencies
multi-vibrator type, 40-200 cy.
D—For low frequencies
counter type, 40-200 cy.
H—For high freqs, up to 20 KC.
M—Power Amplifier, 2W output.
P—Power supply.

This organization makes frequency standards within a range of 30 to 30,000 cycles. They are used extensively by aviation, industry, government departments, armed forces—where maximum accuracy and durability are required.

WHEN REQUESTING INFORMATION
PLEASE SPECIFY TYPE NUMBER

American Time Products, Inc.

Telephone: PLaza 7-1430

Watch Master
Timing Systems

580 Fifth Ave., New York 36, N. Y.

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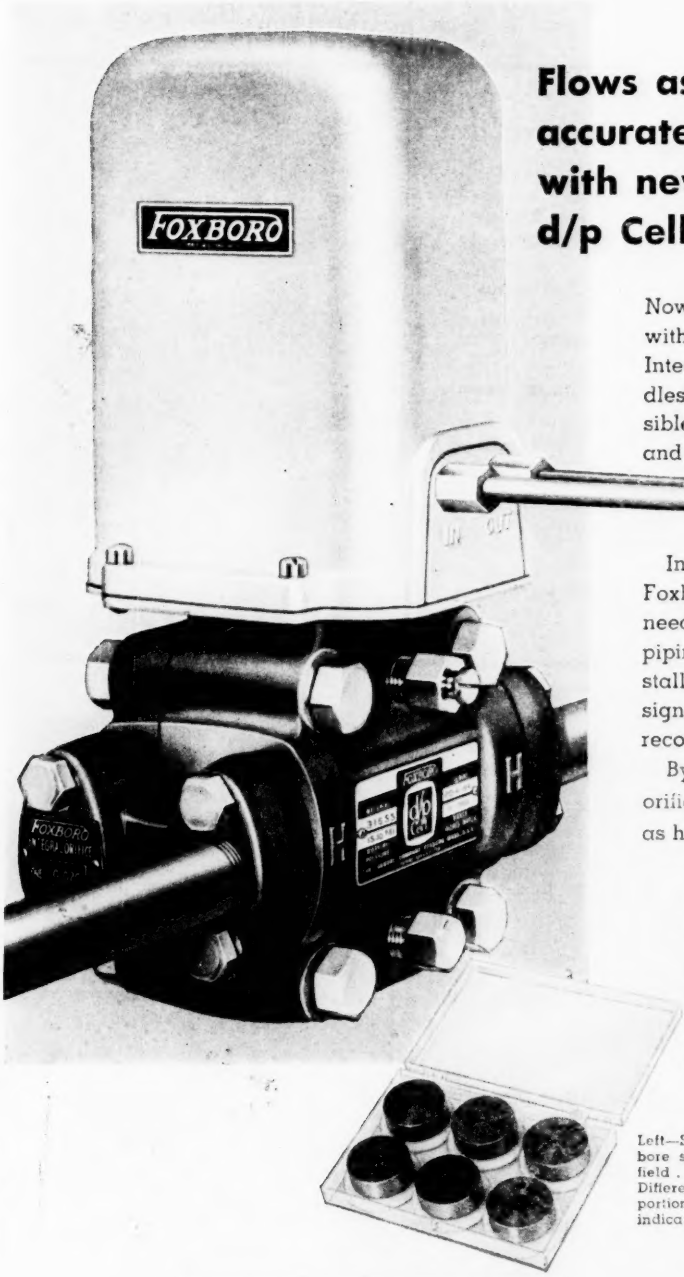
FOXBORO BREAKS "RANGE BARRIER" IN SMALL-FLOW TRANSMISSION



Flows as small as .003 gpm accurately measured, with new Integral Orifice d/p Cell* Transmitter

Now you can measure and transmit small flows with full accuracy and dependability! The new Integral Orifice d p Cell Transmitter easily handles exceedingly low flow rates formerly impossible in pilot plant operations, research problems, and fluid ratioing.

Installed directly in the process line, the Foxboro Integral Orifice d p Cell Transmitter needs no meter primary device or connection-piping . . . and no straight runs. It can be installed in any position. A direct 3-15 psi output signal is delivered to any standard indicator or recorder.

By suitable range selection through change of orifice inserts, flow rates as low as 0.003 gpm or as high as 8.0 gpm can be accurately measured.

The Foxboro Type 13A Integral Orifice Transmitter gives you, not only new high accuracy in measurement, but also accurate remote indicating and recording. Write for complete details. **The Foxboro Company, 468 Norfolk St., Foxboro, Mass., U.S.A.**

*Reg. U.S. Pat. Off.

Left—Set of six interchangeable orifices is available in standard bore sizes from 0.020" to 0.250". They're easily changed in the field . . . merely inserted within the transmitter connection block. Differential pressure across orifice is converted to directly proportional 3-15 psi air output signal and transmitted to remote indicator or recorder.

FOXBORO REG. U.S. PAT. OFF. **INTEGRAL ORIFICE d/p cell transmitter**

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L&N Precision Stabilized Power Supplies guard instrument accuracy against line voltage fluctuations

• Leeds & Northrup has developed two types of power supplies to meet the precision requirements of our own instruments such as the Recording Spectrometer, the Electro-Chemograph® and the Infrared Gas Analyzer. These power supplies have been so successful that we are now making them available for general use.

For Multiplier Phototubes and Similar High Voltage Applications

Two Independent Output Voltage Sources — Ranges
(1) 500 to 1310 volts d-c across 1 megohm load. Continuously adjustable with coarse and fine dials. *(1; see fig.)*
(2) 480 to 790 volts d-c across 1 megohm load. Continuously adjustable with 12-position coarse dial only. *(2; see fig.)*

Line Voltage Tolerance — 0.01% d-c output change for a change in a-c line voltage from 100 to 125 volts.

Drift—Not more than 0.01% for a period of 8 hours or more, after a 20-minute warmup.

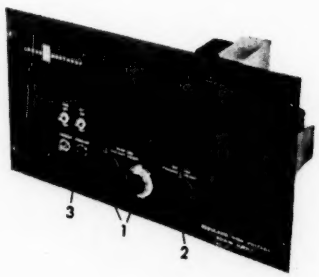
Ripple—Considerably less than 30 millivolts rms.

Time Delay Relay Circuit—30 second time delay allows tube heaters to come to proper operating temperature before high voltage is applied. *(3; see fig.)*

Size—19″ x 10½″ x 10″, for relay rack mounting.

Catalog Number—101038

Price—$938.00 F.O.B. Phila.; subject to change without notice.



For General Purpose Laboratory Applications

Output Voltage Range—105 to 125 volts d-c, continuously adjustable.

Current Range—0–200 ma at 105 volts.

Stability—0.05% d-c output change for a change in a-c line voltage from 105 to 125 volts.

Drift—No greater than 0.05% in 24 hours.

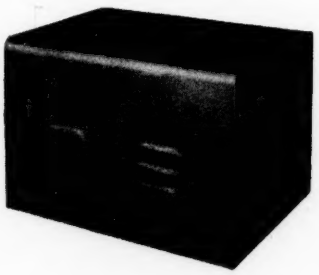
Load Current Regulation—At 105 volts output, load change from 0 to 200 ma produces a 0.05% change in output voltage.

Ripple—Less than 5 millivolts rms.

Size—9 1/16″ x 13 5/16″ x 9 7/8″, with metal case.

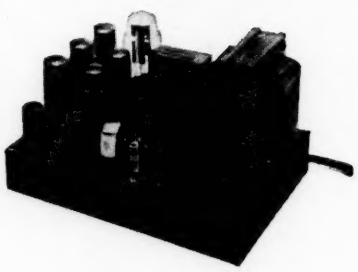
Catalog Number—101-2-0-2

Price—$361.00 F.O.B. Phila., subject to change without notice.



Catalog Number—101-2-0-1, same as above except includes chassis only without metal case and has a constant voltage output of 105 volts.

Price—$266.00 F.O.B. Phila., subject to change without notice.



Order through our nearest district office, or directly from

LEEDS & NORTHRUP COMPANY
4955 Stenton Ave., Phila. 44, Pa.

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Major Manoel F. de Mayo Behar

1889—1958

MAJOR MANOEL F. DE MAYO BEHAR, Ret., Vice President of Instruments Publishing Company and Editor Emeritus of *INSTRUMENTS & AUTOMATION* magazine, succumbed to a coronary disorder August 1st while attending the Gordon Research Conference at Colby Junior College, New London, New Hampshire. He was 69 years of age.

Major Behar, an internationally known figure in the fields of Automation and Instrumentation, wrote and edited the early literature of the field.

Mr. Behar received his education in France, Switzerland, and England; at Pratt Institute (Brooklyn) and Columbia University (New York). As an officer in Army Ordnance, he invented several military instruments. He was technical writer for Johns-Manville Co. (1920-21), research engineer for Brearley Service Organization (1921-23), advertising manager for Edison Storage Battery Co. (1923), and for C. J. Tagliabue Mfg. Co. (1924-29). From 1929 to 1955 he was editor of *INSTRUMENTS* magazine in which capacity he has earned world recognition. From 1955 to the day of his death he served as an active Editor Emeritus on the staff of *INSTRUMENTS & AUTOMATION* magazine. He is author of several books and innumerable articles on Instrumentation.

Behar devoted his efforts for 30 years to formulating the science of Instrumentation, giving lectures, writing articles, and other forms of missionary work. It was in 1924 that he adopted the term "Instrumentation" to denote the unwritten science. Among his "converts" were some American editors of the Encyclopaedia Britannica. His article "Regulation, Automatic" in the 1929 edition is included in the new 1958 edition without change. (He also wrote in 1927 the chapter on Industrial Instruments for Rogers' Manual of Industrial Chemistry.)

Behar's serials in *INSTRUMENTS* from 1930 to 1936 constituted the first formulation of the science of Instrumentation—its evolution from a mass of scattered ideas and data (most of them unpublished) into an integrated mature science.

Behar's many Society Activities included service as Secretary of the National Defense Division of the American Society of Mechanical Engineers from 1923 to 1926, and as member of various ASME technical committees from the 1920's until today. He helped found and organize the Instruments and Regulators Division, and was the first chairman of the Automatic Control Terminology Committee.

During the 1930's, Behar's editorials pointed out the unity of interests of "all men who conceive, design, build, sell, specify, purchase, install, and maintain" instruments and automatic controls. He was active with the representatives of Instruments Publishing Co. in the organization of groups of instrument engineers in several industrial centers—first in Pittsburgh in 1939, then in Chicago, Philadelphia, and New York. This led to the formation of the Instrument Society of America, of which Behar was made an Honorary Member in 1957.

He was also a Fellow of the American Association for the Advancement of Science, Life Member of the American Society of Mechanical Engineers, Charter and Life Member of the Army Ordnance Association, and member of the American Institute of Physics, American Physical Society, American Association of Physics Teachers, National Society of Professional Engineers, Pittsburgh Physical Society, American Institute of Electrical Engineers, American Society of Metals, Federation of Atomic Scientists, Southern California Meter Association, and Institute of Aeronautical Sciences.

Although suffering a heart attack in 1950, he insisted on working continuously on his beloved "Instrumentation," and it is symbolic that his place of demise was the Gordon Research Conference, to which only the leaders of industry are invited. He died serving the instrument industry, for which he dedicated all his life.

Mr. Behar resided at the Wellington Apartments, Pittsburgh, Pa.

He is survived by his widow, the former Sara Pattin.

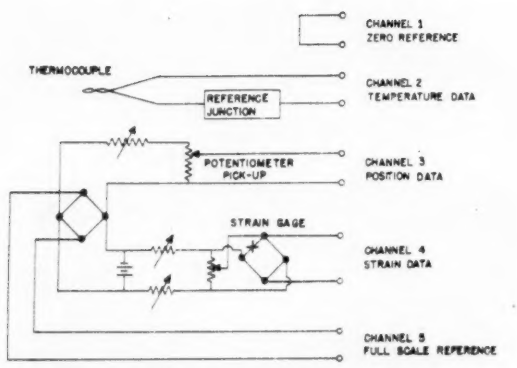


FIG. 1. SCANNING several transducers.

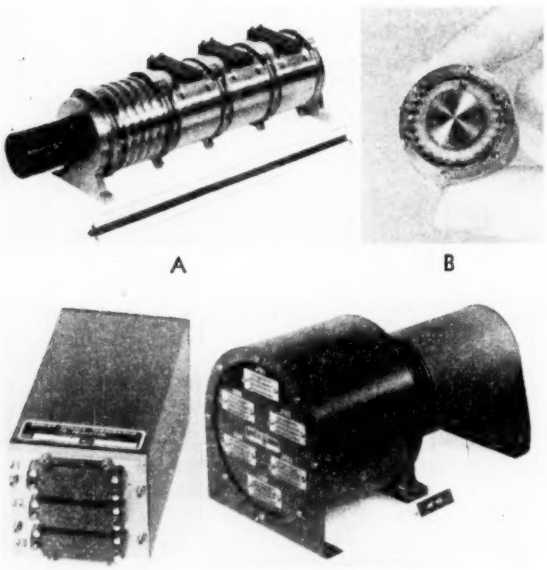
Scanners

The basic types of available scanners include scanning switches and multiplexers, stepping switches, crossbar switches, mercury jet switches, air jet switches, pressure scanners, and electronic commutators.

AS PROCESSES AND SYSTEMS become more complex, the number of variables that must be measured, monitored and controlled becomes ever greater. This leads to increasing need for scanning devices.

The following scanning devices are already available to meet this large and growing need, using mechanical, electrical, electronic, pneumatic, and optical techniques.

FIG. 2. IDL high speed rotary switch.



A B C D

FIG. 3. ASCOP multicoders. A shows Type AU; B shows Type ABM Miniplexer; C shows Type ANM; D shows D series sampling switch.

Scanning Switches and Multiplexers

Fig. 2 shows a 1,000-hour service-free scanning switch produced by Instrument Development Laboratories. This hermetically-sealed instrument provides 2 poles with 45 non-shorting contacts per pole for scanning both high and low transducer signals. A 12,000-rpm motor with a suitable gear reduction system drives the precious-metal brushes at 10 rps on precious-metal contact surfaces. With a signal level of 100 millivolts, the combined contact resistance and self-generated emf-type noise is less than 20 microvolts.

Fig. 3A shows an ASCOP type AU switch with up to 28 poles and 240 pins per pole.

Fig. 3B shows an ASCOP type ABM subminiature "Miniplexer" which has 60 contacts and sampling speeds up to 30 rps. This unit weighs 2.37 ounces, is ¾" long and 1¼" in diameter.

Fig. 3C shows an ASCOP type ANM Miniplexer package for telemetering applications. This Miniplexer has 45 channels and 3 poles.

Fig. 3D shows the Applied Science Corp. (ASCOP) Series-D multicoder for multiplexing and coding up to 86 low-level (0-15 or 0-30 mv) sources, permitting direct action with thermocouples, strain gages and pressure pickups.

The basic Series D is a cylindrical commutator-amplifier package. The amplifier has a gain of 333 (for the 0-15 mv model) or 166 (for the 0-30 mv model) so that the output is 0-5 volts. The variable amplitude of the commutator-amplifier can be converted into variable-width pulses by an auxiliary small keyer-power supply. This PW signal can be used directly to drive an RF transmitter, a tape recorder, or an FM/FM subcarrier oscillator.

Miniature sampling switches of General Devices feature 20 to 45 contacts per pole and adjustable phasing between poles while in operation. The Series 160 sampling switch features one or two poles and up to 120 shorting channels or 60 nonshorting channels per pole.

Mycalex Corp. of America PC commutation switch has operating speed to 1800 rpm, and noise level less than 1 mv. The Mycalex Type CP-299 comprises a standard motor-driven Model TM-55 commutation switch with Supramica 555 Ceramoplastic commutator plates. Noise level is below 50 mv; 32 connector leads can be accommodated.

Stepping Switch

Stepping switches are available with speeds above 100 steps per second.

Fig. 4 shows the Type 45 rotary stepping switch of Automatic Electric. It can be operated by dc or ac (with rectifier). Twelve 25-point bank levels can be assembled on one frame. Automatic Electric also offers a Strowger 2-motion switch that can select any one desired circuit from 100 circuits in approximately 2 seconds.

Telephone-type stepping switches are available from many switch manufacturers. An example of the use of such switches is in Panellit's scanning systems which scan various electrical inputs at a rate of 5 points per second with telephone-type stepping switches. These switches have gold-plated contacts to prevent introduction of thermal voltages when scanning low-voltage inputs, such as thermocouples.

Fig. 5 shows the Type SWM-9610-04 10-pole double-throw hermetically-sealed stepping switch of John Oster Mfg. Co. Minimum life is 10,000 positive electrical cycles and 1000 positive manual cycles. Visual indication shows open or closed switch position. The self-stepping unit contains arc suppressors.

Mercury Jet Switch

The mercury jet switch is a high-speed commutating and sampling switch in which a mercury jet stream, emanating continuously from a central pool, makes sequential contact with pins located circumferentially around the stator. Fig. 6 shows the mercury jet switch of Detroit Controls Div., which can scan 120 circuits at a rate of 60 times/second. Use of the jet results in no bounce, low noise, and long life.

Air Jet Switch

An air jet forces each movable contact against stationary contacts, sequentially, in the Norman Hardy "Roto-Jet" (Fig. 7). The air jet is the only moving part, and noise is said to be extremely low. The model shown has 45 contact pairs, sampling speed of 20 rps;

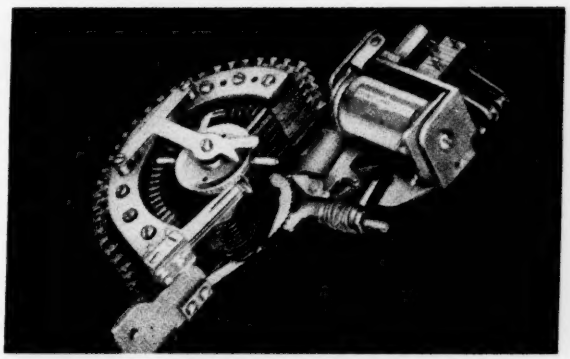


FIG. 4. AUTOMATIC ELECTRIC Type 45 rotary stepping switch.

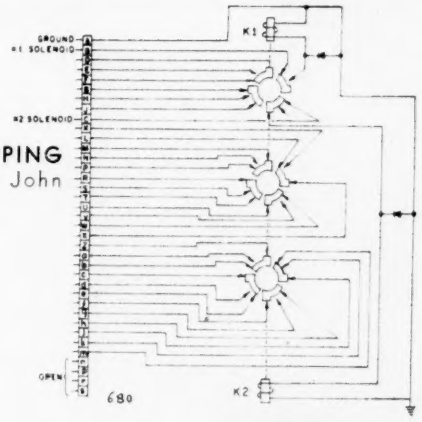


FIG. 5. STEPPING switch of John Oster Mfg.

FIG. 6. DETROIT CONTROLS "Deltaswitch" mercury jet switch.

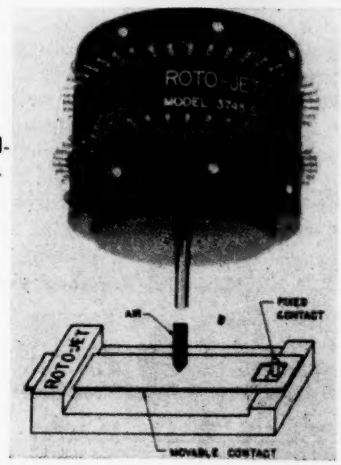
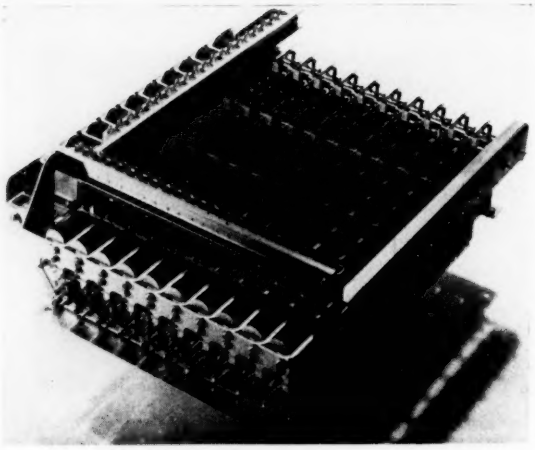


FIG. 7. NORMAN-HARDY Roto Jet.



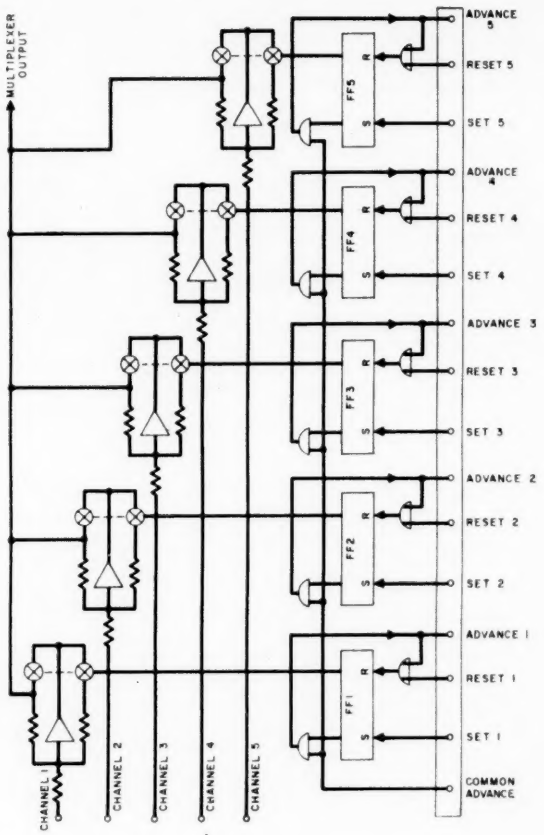
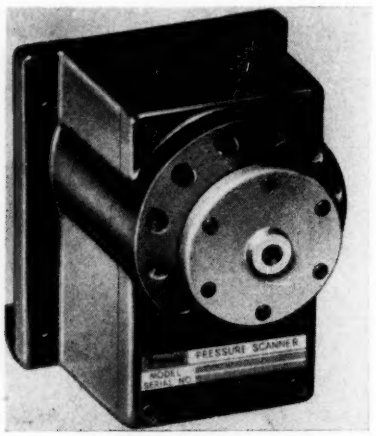


FIG. 8. CUNNINGHAM Type F crossbar switch (above). Associated circuitry to drive switch is shown at right. Beam switching tubes also can be used to drive switch.



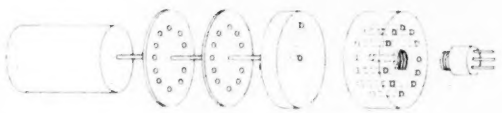


FIG. 9. GIANNINI pressure scanner and drawing showing switching rotor.

contact closing time less than 100 μsec, opening time less than 50 μsec; 2000-hr service-free life at 20 rps; air supply of 2½ cfm at 40 psi.

Crossbar Switches

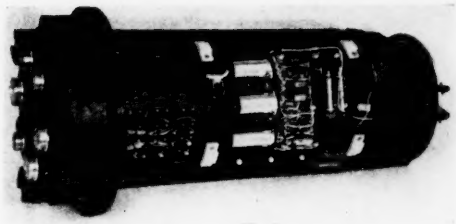
High-speed scanning without the necessity for scanning intermediate points is possible by use of crossbar switches. Fig. 8 shows the Type F crossbar switch of James Cunningham, available in a number of matrix arrangements. Information can be selected from 1200 sources, and the switch can be set up by punched cards, punched tape or telephone-type dials. Illustration shows a 10 x 10 x 6 matrix, with 600 individual crosspoint terminals.

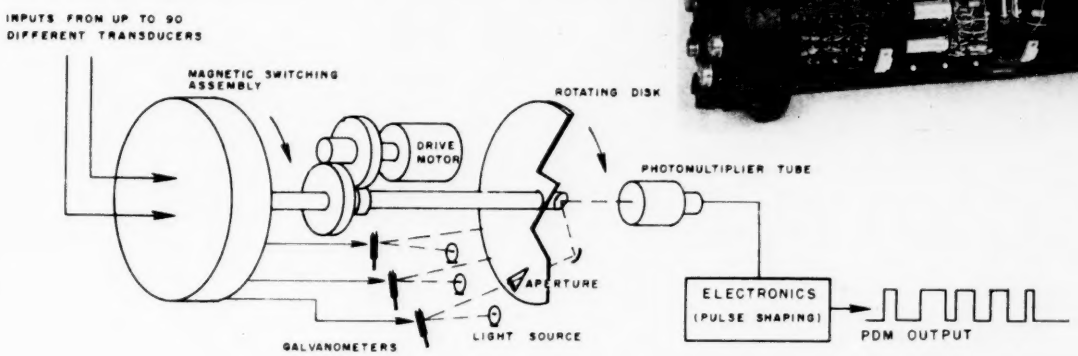
Giannini Pressure Scanner

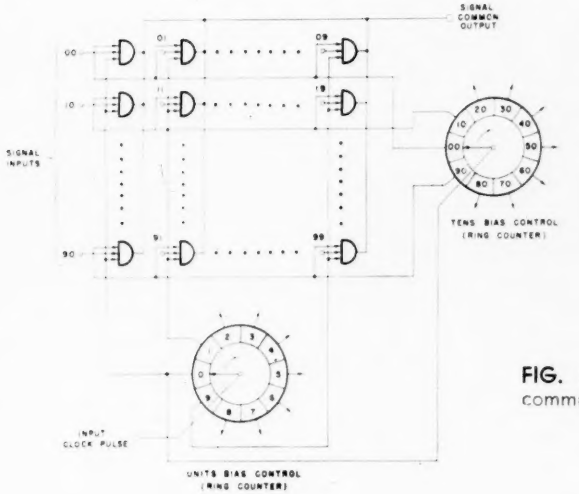
The Giannini pressure scanner comprises a stator having 12 input ports, and a rotor that connects any one of the input ports to the center output port (Fig. 9). Thus one pressure transducer can sense twelve inputs. The rotor is rotated to a desired position by a unidirectional high-torque motor acting as a positioning servo. The motor operates the rotor in any position selected externally by a switch. A 12-position switch inside the scanner is connected to an external 12-position switch so that when both switches are on the same position the motor circuit is opened and the motor stops. A circuit in the control unit provides dynamic braking to stop the motor when rotor and stator ports are in coincidence. An additional bank of contacts on the internal switch indicates rotor position either visually by lights, or in digital form for recording devices. The positioning system allows points to be skipped or scanned in any desired sequence by remote control. Free-running speed is 20 rpm. The transducer port can be vented to a base pressure between input ports, minimizing transducer hysteresis effects.

By using one pressure scanner to interrogate twelve other pressure scanners, as many as 144 pressures can be measured with only one transducer. However, where a plurality of transducer ranges is required, the input pressures can be connected to separate pressure scanners each associated with the range which will offer greatest accuracy.

FIG. 10. CEC Plexicoder. Drawing (below) illustrates radial galvanometer deflection and wedge-shaped aperture.







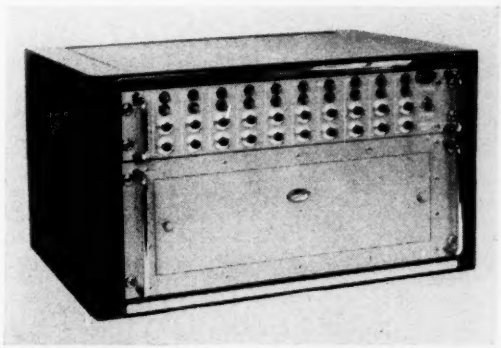


FIG. 11. WIANCKO Series 25-1100 high-speed commutator. Circuitry is shown at left.

CEC Plexicoder

The Plexicoder of Consolidated Electrodynamics Corporation (Fig. 10) can commutate from 90 transducers at 900, 225, or 112.5 samples per second, and can convert the signal to a pulse-width-modulated signal.

Each input signal is fed through two sealed magnetically-operated switches, which act as a double-pole single-throw switch to a galvanometer. There are 15 galvanometers, each of which can receive up to 6 different inputs sequentially. The galvanometer deflection is translated into a pulse width via a wedge-shaped aperture. The light passing through the aperture is reflected to a single photomultiplier tube.

Let us consider the 112.5-sample-per-second unit. The aperture disk rotates at 7.5 rps; the 15 galvanometers are scanned on one revolution of the aperture disk, giving 7.5 samples/second/input. If there are 30 inputs, the second set of 15 are switched to the galvanometers for the second rotation of the aperture disk, giving 3.75 samples/second/input. For 90 inputs, six revolutions of the aperture disk are required to scan all 90 inputs and each input is scanned at 1.25 samples/second. Note that the commutator rate is always 112.5 samples per second.

Wiancko Electronic Commutator

Microsecond switching requires electronic commutation. Fig. 11 shows a 100-channel commutator that uses solid-state elements. It accepts a-c or d-c inputs (from ±10 mv to ±5 volts) and switches them sequentially at 30,000 per second (10-microsecond max switching time). The unit comprises 100 "AND" gates as shown in Fig. 11. The center input to each gate carries the signal to be switched; the upper input is connected to a tens ring counter; the lower input to a units ring counter. The ring counters are triggered by a clock pulse. Only when the proper gate is energized by the two ring counters can the input signal reach the output. Inherent noise level is less than 10 microvolts.

General Devices Electrocom

The Model 1300A Electrocom of General Devices Company is an electronic switch with up to 4 poles, 24 non-shorting channels, which can sample each channel at a rate of 24,000 samples/minute. It is only 2″ x 2″ and weighs 1 lb.

FIG. 12. ELECTRO Instruments Master-Slave units.

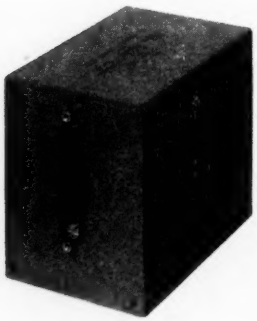


FIG. 13. ARNOUX PDM Series in new housing style.

FIG. 14. CUBIC CORP. Scanner.

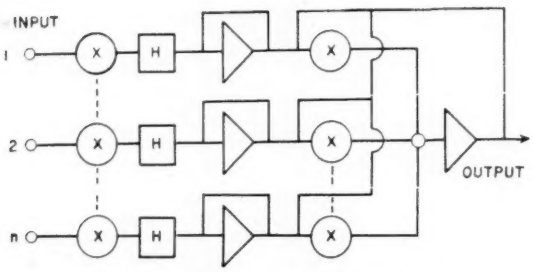


FIG. 15. TYPICAL TMX-SHCS Series.

FIG. 16. EDISON Omniguard substitutes direct monitoring by Wheatstone-bridge circuits in order to monitor many channels.

Electro Instruments Master-Slave Combinations

With Electro Instruments "Master-Slave" combinations up to 10,000 channels can be scanned automatically. The Master module handles 100 channels; slaves handle multiples of 300 (Fig. 12).

These units can accommodate 1, 2, 3, or 4 wire switching. Solid-state electronics is featured, including transistor-driven stepper switches.

Arnoux Electronic Commutator

The Arnoux Series PAM 30 provides 28 information channels; five sampling speeds range from 2.5 to 30 samples per second per channel.

The Arnoux PDM Series (Fig. 13) is available with 30, 45 or 90 channels; commutation rate is 900 pulses per second, from 10 to 30 samples per second per channel.

Cubic Corp. Master Scanner

The Cubic Corp. master scanner (Fig. 14) can drive 10 to 40 100-point auxiliary scanners to scan 1000 points with 1, 2, or 4 wires each. Operational modes are (1) remote, where channel is selected by remote command, (2) manual, where start button sets scanner to preselected low channel, (3) auto scan that scans automatically from selected low channel to selected high channel, (4) auto reset (same as auto scan but with continuous recycling). Channel limit selectors on the front panel select low and high channels.

Epsco TMX Series (Exclusive Disclosure)

While going to press we received notice that Epsco is introducing a new line of solid-state multiplexers, the TMX Series (Fig. 15).

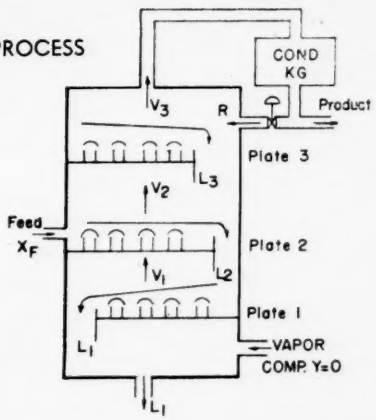
The TMX Series will be able to (1) commutate multiple inputs to a single output, (2) distribute a single source to multiple outputs, and (3) simultaneously sample multiple sources and then transfer them sequentially (in arbitrary sequence). These operations are performed at a rate of up to 50,000 switching actions per second. Up to 200 inputs (or outputs) are available. Switch time for high-speed input is 7.7 μsec (0.1% transfer accuracy), or 10 μsec for 0.05% accuracy.

Other special features will include: (1) low output impedance (app. 1 ohm) for driving other units with high accuracy, (2) high input impedance (from 1 Kohm to 1 megohm in four ranges) to prevent undue loading of data sources, (3) transfer accuracy essentially independent of semiconductor characteristics, (4) crosstalk 60-db down for 100 channels in worst combination, (5) optional interlaced programming, (6) multiple range, (7) low-level switching, (8) synchronous or asynchronous operation, (9) linearity better than 0.05%.

The basic switch, buffing unit, holding and control elements can be combined into four distinct switch types: (1) commutating, (2) distributing, (3) sample-and-hold commutating, and (4) distributing-and-hold switches.

Simulation Bulletin 2

FIG. 1. PROCESS



Problem: To simulate distillation-column dynamics on an analog computer. The model chosen is a 3-plate binary distillation column.

Distillation-Column Dynamic Characteristics

ALTHOUGH the equations for a single component are solved, the column being represented (Fig. 1) is in effect a binary column because the vapor and liquid compositions are expressed in mol fractions. Since the total vapor and liquid is unity, the composition of vapor and liquid for the second component are:

$$y_2 = 1 - y_1$$
$$x_2 = 1 - x_1$$

Symbols

- L = liquid rate of flow in column, lb-mols/min.*
- V = vapor rate of flow in column, lb-mols/min.
- x = mol fraction of component in liquid state (%).
- y = mol fraction of component in vapor state (%).
- F = feed rate of liquid feed to column, lb-mol/min.
- D = distillate rate of material leaving column, lb-mols/min.
- R = reflux ratio L/D, dimensionless.
- DR = liquid reflux back into column, lb-mols/min.
- τ = time constant of reflux condenser, minutes.
- H = plate holdup, lb-mols.
- δ = effective resistance to hydraulic flow from plates.

Basic Problem

In the simulation, it is desired to examine the effect of feed composition (x_F), feed flow rate (F), distillate flow (D), vapor flow (V), plate hold-up (H), and reflux ratio (R). The basic equations used are taken from the thesis "A Mathematical Investigation of the Problem of Transients and Control in a Distillation Column" by T. J. Williams.

*Subscripts refer to plate areas—that is, L_1 is rate at plate 1, L_2 at plate 2, etc.

Based on Simulation Bulletins of Electronic Associates, Inc.

Basic Equations

The equations expressing the liquid *fractions* are obtained by writing a material balance equation around each plate:

$$H \frac{dx_3}{dt} = V_2y_2 + DRx_R - L_3x_3 - V_3y_3$$

$$H \frac{dx_2}{dt} = V_1y_1 + L_3x_3 - L_2x_2 - V_2y_2 + Fx_F$$

$$H \frac{dx_1}{dt} = L_2x_2 - L_1x_1 - V_1y_1$$

Dimensionally, the left-hand term has units of (lb-mols) (1/min); each right-hand term has units of (lb-mols/min). Thus the equations check dimensionally.

The *liquid flow* on the column plates can be expressed by a first order equation:

$$H\,\delta \frac{dL_3}{dt} = DR - L_3$$

$$H\,\delta \frac{dL_2}{dt} = L_3 + F - L_2$$

$$H\,\delta \frac{dL_1}{dt} = L_2 - L_1$$

In order for the dimensions to check, the coefficient of the rate of change term in the equation must have the dimensions of time. Since H is a capacitance term, δ must be a resistance term. Thus H = lb-mols and δ = 1/lb-mols/min.

Simulation of Mass Transfer Equation

The mass transfer equation is:

$$y = \frac{a\,x}{1 + (a-1)\,x}$$

where a = relative volatility.

This nonlinear expression is simulated by loading a potentiometer cup of a servomultiplier (30,000 ohms) with a resistance of 3,000 ohms. This gives a curve of y vs x which is equivalent to the above expression. This nonlinear function is generated by the circuit shown in Fig. 2.

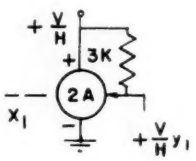


FIG. 2. SERVOMULTIPLIER generates nonlinear function $y=ax/[1+(a-1)x]$. Note that x is one of the two inputs to the servomultiplier; y is the output.

Simulation of Material-Balance Equation

Let us simulate the material-balance equation:

$$H\frac{dx_1}{dt} = L_2x_2 - L_1x_1 - V_1y_1$$

We would like to generate $100x_1$ for voltage reasons: Hence the equation becomes:

$$100\frac{dx_1}{dt} = 100\frac{L_2x_2}{H} - 100\frac{L_1x_1}{H} - 100\frac{V_1y_1}{H}$$

The simulated circuit for this expression is shown in Fig. 3.

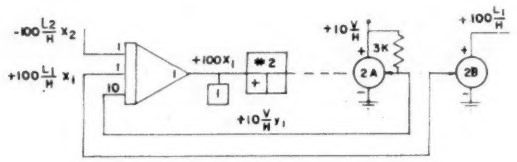


FIG. 3. CIRCUIT for the term $100\,dx_1/dt$. Inputs to integrator 1 must equal $100\,dx_1/dt$ because output is $100\,x_1$.

We desire to make a time scale change to speed the solution. This calls for an increase in the integration rate—in essence, an increased gain at the input to the integrator. Let us pick a time scale change of 100. This means that the integrator gains must be 100 times what they were originally. Instead of applying this gain at the integator we can increase the signals to the integrator by a factor of 100, as shown in Fig. 4.

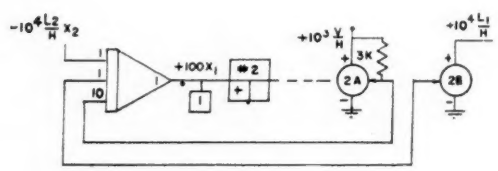


FIG. 4. TIME SCALE can be effectively multiplied by 100 simply by increasing all inputs to integrator by an amplitude factor of 100.

Note that the integrator output remains $100x_1$ despite this increased gain.

Simulation of Liquid Flow Equations

Next let us simulate the equation for liquid flow:

$$H\,\delta\frac{dL_2}{dt} = L_3 + F - L_2$$

Applying the scale factor for voltage reasons:

$$\frac{10^4}{H}\frac{dL_2}{dt} = \frac{10^4L_3}{H^2\,\delta} + \frac{10^4F}{H^2\,\delta} - \frac{10^4L_2}{H^2\,\delta}$$

The simulation circuit is shown in Fig. 5.

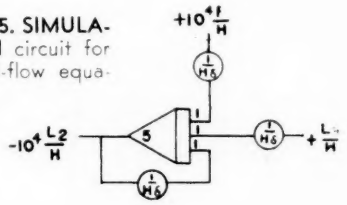


FIG. 5. SIMULATION circuit for liquid-flow equation.

A time scale change again must be made. Therefore, each pot on the input of the integrator must be multiplied by 100. However, the pot setting of $100/H\,\delta = 1$ because $H = 1000$ and $\delta = 0.1$, as will be shown. So we omit the pot to give the circuit shown in Fig. 6.

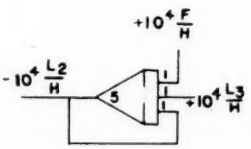


FIG. 6. CIRCUIT for liquid-flow equation with time scale change of 100.

Simulation Circuit for Top Vapor Composition

Since a total condenser is assumed, x_R is equal to y_3. Integrator 7 is used to simulate the lag of the condenser. The equation is:

$$\tau\frac{dx_R}{dt} = y_3 - x_R$$

where τ is the time constant of the reflux condenser, in minutes.

Applying the scale factor:

$$10\frac{dx_R}{dt} = \frac{10y_3}{\tau} - \frac{10x_R}{\tau}$$

The circuit for this equation is shown in Fig. 7.

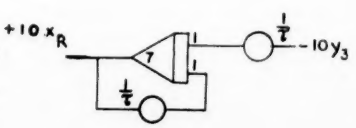


FIG. 7. CIRCUIT for obtaining x_R.

Again, the time scale change must be made so that the circuit becomes that shown in Fig. 8.

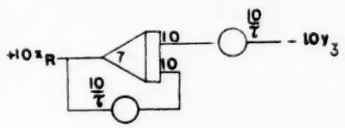


FIG. 8. APPLYING time-scale change to Fig. 6.

As $10/\tau = 1.0$, the pots are omitted in the final circuit, shown near the top in Fig. 9.

Final Simulation Circuit

The complete circuit is shown in Fig. 9.

Servo cup 4B generates the top vapor composition of the reflux stream (y_3), as shown in Fig. 9.

The inputs to integrator 3 solve the equation for x_3, which is read out on recorder channel 3.

The inputs to integrator 2 solve the equation for x_2, which is recorded on recorder channel 2.

Recorder 1 records x_1; recorder 4 records x_F; recorder 5 records V/H; recorder 6 records x_B.

Calculation of Pot Settings

The following values are assumed:

$$H = 1000 \text{ lb-mols}$$
$$V = 5.5 \text{ lb-mols/min}$$
$$R = 3.5$$
$$\tau = 10 \text{ minutes}$$
$$\delta = 0.1 \text{ min/lb-mols}$$
$$x_F = 0.5$$
$$F = 1.5 \text{ lb-mols/min}$$
$$D = 0.75 \text{ lb-mols/min}$$

Hence the pot settings become:

Pot 22: $R/10 = 3.5/10 = 0.35$

Pot 23: $10^5 D/H^2\ \delta = (10^5)(0.75)/(10^6)(10^{-1}) = 0.75$

Pot 24: $10^3 D/H = (10^3)(0.75)/10^3 = 0.75$

Pot 26: Constant $= 0.1$

Pot 27: $10^2 F/H = 10^2(1.5)/10^3 = 0.15$

Pot 28: $x_F = 0.5$

Pot 29: $10\ V/H = (10)(5.5)/10^3 = 0.055$

The vapor rate is assumed constant in the column; its value is a function of the heat applied to the bottom of the column.

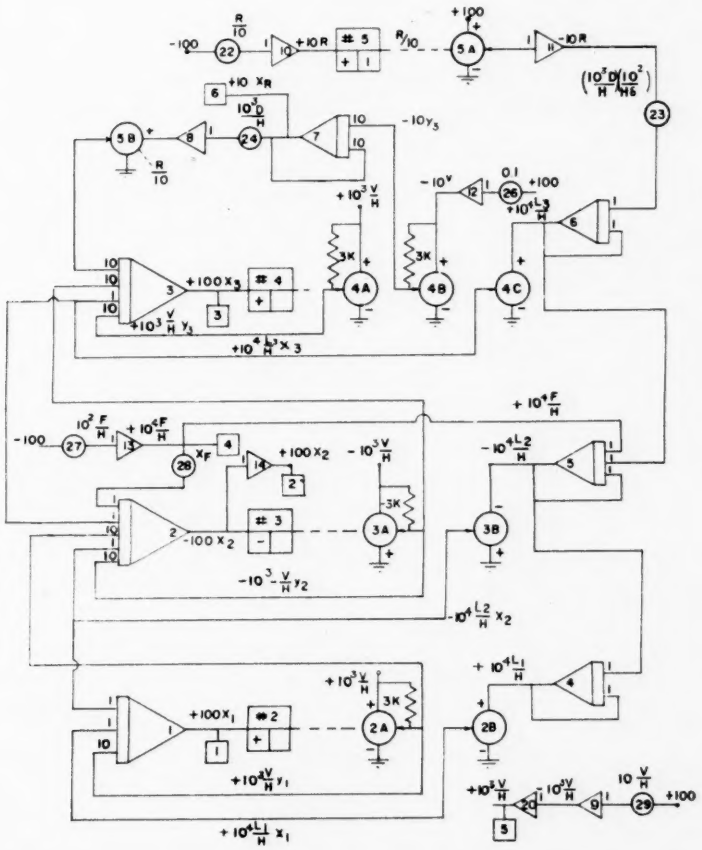


FIG. 9. FINAL complete simulation circuit.

RECORDER SURVEY

PART II

Principles and features of various electrical-signal recorders were discussed in Part I (May issue). Here are tabulated performance specifications supplied us by manufacturers of available recorders, grouped according to principle of operation.

TABLE 1—DIRECT WRITING RECORDERS USING GALVANOMETERS

MAKE	TECHNIQUE	CHANNELS	FREQUENCY RESPONSE	CHART SPEEDS	FEATURES
Acton 550-A	Scribes on carbon-coated 35-mm acetate film. 5x optical magnification for viewing	8	300 cps uncompensated; 800 cps (±5%) with driver amplifier	5 speeds from 1 to 16 cm/sec	High resolution (trace width 0.01 mm)
Brush RD Series	Some models ink or electric writing; some thermal writing (rectilinear)	2 to 8	Flat to 100 cps, can read to 300 cps	16 speeds, electric remote control	Trace width—0.01" or 0.015" (ink); 0.005" (electric); 0.015" (thermal)
Brush Mark II	Ink	2	Same	4 speeds, from 1 to 125 mm/sec	Portable (32 lbs); trace width—0.015"; built-in, calibrated amplifier
Curtiss-Wright, Models 81 to 87	Ink and heat, both rectilinear (linkage)	1 to 6		Six speeds	Standard, miniature and double-size models; for ac-dc recordings
Douglas & Gierens RA 1000 RB 1000	Ink or electrosensitive	1		15 cm/min; others available	Accessory converts to x-y recording; 12 lb
Edin Models 8080-8090, 8501, 8604	Ink, ink and electric, or hot-stylus rectilinear	1 to 10	Depends on galvanometer; 150 cps without comp; 350 cps with comp.	6 or 9 speeds from 0.05 to 500 mm/sec.	8501 has Z-fold chart
Electro-Medical Garceau Velograph	Electrosensitive	1 to 8; to 20 special	to 75 cps; rise time 0.01 sec.	200 mm/sec	Also used for EEG and biological research; line width 0.01"; portable
Electronic Associates Type 99.003	Hot-wire, rectilinear	8	Flat to 40 cps with compensation	From 0.4 to 100 mm/sec	Provides remote control of computer; accuracy ±0.5% over center 20 mm; automatic scale calibration
Esterline-Angus	Ink, PMMC for dc; electrodynamometer for ac volts, watts, etc.	1, 2	0.5-sec full-scale response when critically damped.	From ¾"/hr to 3"/sec	Magnetic damping; portable and flush models; driven by hand-wound or motor-wound spring, or synchronous motor
GE Type CH	Ink, PMMC for dc; electrodynamometer for ac volts, watts, vars; attraction-repulsion iron vane for ac amps	1	0.7 sec full scale	28 speeds from ¼"/hr to 2"/sec	Various spring and electric drives; 60-day spring clock; 150' record roll
Geotechnical Helicorder	Hot stylus on drum, using helical trace	1 to 3	to 24 (± 2 db) with amplifier (50 ms full-scale deflection)	10 to 90 mm/min	Up to 72 hrs. recording time per sheet of paper (1' by 3'); trace width 0.005"; used in seismology
Goodyear GEDA GN 215-R5	Ink, curvilinear	6	100 cps	1, 25 and 125 mm/sec	Designed for computer readout—desk-type console
Mandrel ER-20	Electrosensitive, rectilinear	1 to 4	Flat to 60 cps		Sensitivity 2 mv/mm with 40-mm max pen swing; 100' roll
Massa GA-1023 and RE-12	Ink or electric, rectilinear (linkage)	2 (1023) 12 (RE-12)	± 1 db to 100 cps, ± 2 db to 200 cps (with amplifier)	GA-1023—2,20, 200 mm/sec; RE-12—9 speeds from ½ to 200 mm/sec, or cm/hr	Acoustic damping eliminates overshoot and ringing; remote control; footage indicator
Mid-Century MC-300	Ink or electric, curvilinear or rectilinear (conversion kit)	6	100 cps (flat to 40 cps)	12 speeds, from 0.5 to 50 mm/sec	Adapted to computer readout and control; one or two marker channels; internal st'd cell for calibration

TABLE 1—DIRECT WRITING RECORDERS USING GALVANOMETERS (Cont.)

MAKE	TECHNIQUE	CHANNELS	FREQUENCY RESPONSE	CHART SPEEDS	FEATURES
Millivac MR-87A	Ink or electric	2	Flat to 30 cps, 3 db down at 60 cps		Chopper-stabilized d-c amplifier (transistorized)
Offner Dynograph M, MC, MR, MCR, MRS, MCRS, and P	Either ink or electric (curvilinear); electric or heat (rectilinear)	1, 2, 4, 8, or more	Within 10% to 70 cps	8 speeds, from 1 to 250 mm/sec	All include drift-free chopper amplifier
Offner Dunograph Type R	Same	1 to 8	Within 10% to beyond 150 cps	Same	All transistorized
Offner Dynograph Type 542	Same	2	200 cps	7 speeds, from 1 to 100 mm/sec	Compact (45 lbs); transistor amplifier
Photron F6A F1, F2, F4, F6C, and F8	Ink or heated stylus (rectilinear); ink or electric (curvilinear)	6 (F6A and F6C), others 1 to 8	Flat to 35 cps without compensation; to 100 cps with compensation	From 0.1 to 250 mm/sec	Interchangeable recording techniques
Reeves Instrument RE400-1	Ink (standard) or electric	6	Flat to 30 cps; 3-db to 70 cps for 10-20% of full deflection	8 speeds, from 1 to 250 mm/sec	Specially designed for computer readout and control; records zero, scale, offset, speed settings, run number
Sanborn Series 150, 350, 850	Heated stylus, rectilinear	1 to 8	Flat to 100 cps 3 db at 120 cps (for 350 Series)	9 speeds, from 0.25 to 100 mm/sec	Large line of amplifiers and interchangeable preamps
Sprengnether Series VR-40-0	Ink	1		30 or 60 mm/min	24 hrs on 12" x 36" paper; for seismological work
Stoelting Model 22650	Ink	Up to 9		8 speeds, 0.25 to 50 mm/sec	Special amplifiers for medical work; Z-fold paper; chopper amplifier
Texas Insts. Recti/Riters	Ink, rectilinear (linkage)	1, 2	1/4-sec pen speed over 4 1/2" chart	10 speeds, from 0.75 to 12 in/min or in/hr	Basic 1-ma movement; large line of accessory amplifiers; model 350 has 7 ranges ac and dc
Westinghouse Type 44	Ink	1		3/4 to 12 in/hr or in/min	PMMC, electrodynamometer or attraction-iron movements for ac-dc recordings

TABLE 2—RECORDERS USING GALVANOMETER LIGHT-BEAM TECHNIQUES

MAKE	TECHNIQUE	CHANNELS	FREQUENCY RESPONSE	CHART SPEEDS	FEATURES
Century Electrograph 420, 422 (airborne)	Electrophotosensitive (Electrofax) paper	to 24	Depends on galv.	7 speeds, from 1/8 to 8"/sec	Daylight loading; dry developing; timing lines; identification marks; 200' roll can run 320 hrs
Century Electrograph 421	Same	40	Same	Pushbutton selection from 1/4 to 16"/sec	Rack mounted; 500' roll
Consolidated Electrodynamics Model 5-114	7" film or paper	18 or 26	Depends on galvanometer; fluid-damped has response to 5000 cps	1/2 to 115"/sec	Interchangeable magazines with up to 225' rolls; timing lines; remote operation; automatic record and event numbering; Datarite processor processes film at 1/2 to 28"/sec while recording
CEC 5-116	5" film or paper	14	Same	1/4 to 100"/sec	200' magazine
CEC 5-117	70 mm film or paper	6	300 cps magnetically damped; fluid damped higher	3/4 to 24"/sec	150' capacity
CEC 5-118	3 1/2" film or paper	9 or 12	300 cps	1 to 6"/sec	60' of paper
CEC 5-119	12" film or paper	36 or 50	Depends on galvanometer; 5000 cps fluid damped	16 speeds, from 0.1 to 100"/sec	Accessories include crash-resistant magazine; 400' capacity
CEC 5-122	8" film or paper	26	To 3000 cps	0.047 to 96"/sec	225' capacity; for airborne use
EPIC Lumiscript (Hartman & Braun)	Mercury vapor lamp; ultraviolet-sensitive chart 35, 45, or 60 mm wide	4	16 galvanometers available with natural frequency to 570 cps	0.5, 2.5 and 5"/sec; to 400"/sec without outside motor	Requires no developing; record immediately visible and permanent; 0.5% accuracy

TABLE 2—RECORDERS USING GALVANOMETER LIGHT-BEAM TECHNIQUES (Cont.)

MAKE	TECHNIQUE	CHANNELS	FREQUENCY RESPONSE	CHART SPEEDS	FEATURES
Geotechnical Model APR	16-mm film	24	Depends on galv.	3 cm/min; others available	Automatic film processing (internal) within 10 minutes; 10x magnification system for viewing; optional time, date, and record printing; 1000' roll
Geotechnical Film Recorder	35-mm film	4	Depends on galv.		Uses motion-picture film.
Hathaway S-14 E	6" paper	6 to 24	Depends on galv.	9 speeds, from 0.1 to 40"/sec	Daylight loading; economy model
Hathaway S-25	8" or 12" Paper	to 48	Depends on galv; available with natural frequency to 10,000 cps	Pushbutton selection of 12 speeds, from 1/16 to 160"/sec; 24" length can be recorded at 1200"/sec	Remote operation; 300' chart; automatic record numbering, length control, and time-line intervals from 1 to 0.001 sec; automatic lamp replacement on burnout
Honeywell Series 700C	Photosensitive paper from 1" to 12" wide	1 to 60	Galvanometers available with natural frequency above 8000 cps	24 speeds, from 0.03 to 144"/sec	Up to 300' record length (33.3 hrs recording time); timing lines from 0.01 to 10 seconds; automatic record length control; automatic record numbering; trace identification; lamp burnout indicator
Honeywell Visicorder 906 A	Uses special 6" width paper (and light source); paper is insensitive to room light.	6 to 12	Depending on galv. to 5000 cps without peaked amplifier	0.2 to 50"/sec; 0.1 to 25"/sec, min, or hr	100' of paper; no processing; immediate readout; weighs only 37 lbs; each trace can have 6" deflection
Honeywell Visicorder 1012	12" Visicorder paper (no chemical processing)	1 to 36	Depends on galv; to 5000 cps without amplifier	0.1 to 160"/sec; 5 speeds in 3 ranges by pushbutton	200' of paper; each trace can have 8" deflection; writing speed up to 20,000"/sec; trace identification, timing and grid lines recorded simultaneously with trace
Mandrel Electro-Tech ER-102	10" or narrower paper	to 50	to 1000 cps depending on galv.	From 0.1 to 48"/sec	Flash timing lines
Midwestern 606 D/R, 602 D/R	Uses special high-intensity source plus D/R (direct recording) paper that requires no developing or processing. 606 also can use standard paper.	to 50	Depends on galv.	602 D/R has 0.0865 to 138.5"/sec; 606 has speeds from 0.071 to 173"/sec	0.01 and 0.1 sec timing lines; record numbering and trace identification; 12" record width; remote control pushbutton speeds; 606 has flash timing system
Midwestern 616 D/R	Uses special D/R paper	to 25	Same	0.5 to 50"/sec	7" record width
Midwestern 615	Uses special D/R paper	to 14	Same	Same	5" record width
Midwestern 590, 591	8" paper (590) 12" paper (591)	to 36 (590) to 50 (591)	Same		Timing lines; record numbering; trace identification
Midwestern 580, 581	3½" film	14	Same	0.5 to 44.75"/sec	400' film capacity
Midwestern 561, 560, 560B	3½" film	14	Same	0.39 to 8"/sec (560); 0.5 to 80"/sec (561)	Shock resistant models for missiles, etc; Model 560B withstands 3000 G
Sanborn 550 Series	6" wide paper available to each beam	4, 6, or 8	Depends on galv.	8 speeds, from 1.25 to 200 mm/sec	Daylight loading; paper drive and footage indicators; code marker; remote control; 200' chart; timing lines; Vector timex for medical vectorcardiography work

TABLE 3—SPECIAL GALVANOMETER-TYPE RECORDERS

MAKE	TECHNIQUE	CHANNELS	FREQUENCY RESPONSE	CHART SPEEDS	FEATURES
General Electric	Galvanometer deflects mirror; photoelectric follower causes recording elements to follow motion of galvanometer by servo action	1			Models for voltage, current, power, etc.
GE Type CF	Striker bar presses pointer against typewriter ribbon once every 2 seconds making impressions on paper	1	Limited by 2-sec action of striker bar	1, 2 or 3"/hr, or 1"/day	Models available as hook-on recording volt-ammeters, ac and dc voltmeters, ammeters, etc.
Rust Rustrak Model A	Bar presses pointer on pressure-sensitive paper every 2 sec; rectilinear		Limited by 2-sec action of bar	6 speeds, from 1 to 30"/hr	Basic 1-ma movement adaptable to ac and dc recordings; 63' chart roll; low cost; 2% accuracy; size only 3⅝" x 5⅝" x 4⅛"

TABLE 4—SELF-BALANCING POTENTIOMETER RECORDERS

MAKE	CHANNELS	ACCURACY	FULL-SCALE RESPONSE (SEC)	CHART SPEED	FEATURES
Bailey Class E	1 to 4	±1/4%	1 or 5	4 min to 7 days (round chart) electrical, mechanical or pneumatic drives	Available with bridge input; 4 receiver units can be mounted in one case; 10" round chart
Bristol Dynamaster Round Chart	1, 2	±1/4%	0.4, 1, 3, 4 1/2, 12, 24	8 hrs to 7 days st'd; other available	Available with bridge input and differential transformer input; 12" chart
Bristol Dynamaster Strip Chart	1 or 2 pens; multipoint to 24 points	±1/4%	0.4, 1, 3, 4 1/2, 12, 24	3/4"/hr to 240"/min	12 1/4" chart (11" calibrated); available with bridge input and differential transformer input
Bristol Dynamaster Series 663 Miniature	1	±1/2%	1, 2	1 to 4"/min 10 to 40"/min	3" wide chart, 65' roll; available with bridge input and differential transformer input
Daystrom-Weston 6800 Series Circular Chart	1	1/4%	5 sec	24 hr to 7 days	12" round chart
Daystrom-Weston 6700 Series Strip Chart	1 pen or 2 pen (2 zone) or 24 points with printwheel	1/4%	1 sec	1/2 to 960"/hr	11" chart of 120' length; 2-zone chart divided into two 4 1/2" widths; plug-in components for quick change from 2 to 24 points
Engineering Enterprises SP-1-10	1		2	0.5"/hr to 6"/min	Portable; weighs only 15 lbs; 10" chart; 100' roll
Ess SIR-7L	1	1/4%	8 sec	24 hrs	12" round chart; used with maker's smoke and turbidity units
Foxboro Dynalog Round Chart	to 24 with segmental recording	1/4%	3; 1 to 60 available	1 min to 7 day	Uses Dynapoise drive; 12" round chart; stepless capacitor rebalancing; continuous reference to standard cell
Foxboro Dynalog Strip Chart	1	1/4%	Same	3/4 to 12"/hr, or "/min, or "/sec (with second drive motor)	Same; 6" chart
General Electric	1	1/4%	4, 12, 24	24 hr	12" round chart; indicator has 24" scale around periphery; operates to 125°F by using magnetic standard
Hagan Powrlog	1 to 4	1/2%	2	24 hr	12" circular chart. Can be dc potentiometer or 60-cps a-c servo-operated resistance bridge
Hays Universal	1 to 4	0.2%; ±20 uv for spans less than 10 mv	4 to 5	24 hr	12" circular chart; 29" indicator scale around periphery; Constant-voltage source (no standard cell)
Leeds & Northrup Speedomax Type G Strip Chart	1	0.3%	3, 2, 1, and faster than 0.4	1/2" hr to 1"/sec	9 7/8" wide strip chart; up to 100 points can be recorded with auxiliary stepping switch (number printed beside each dot)
Leeds & Northrup Speedomax Type G Round Chart	1	0.3%	4 and 3	3 min to 7 day	28" calibrated scale with 3 1/2" calibrated radius on chart; polar recorder (x vs angular displacement) for distribution patterns, etc.
L&N Speedomax Type H Strip Chart	1	0.3%	5 and 1	1/4 to 60"/hr	6 1/2" wide strip chart; smaller version of Type G
L&N Speedomax Type H Round Chart	1	0.3%	5 and 1	24 hr, 8 hr, or 48 min	23" calibrated scale; 3" calibrated chart radius; smaller version of Type G
MM&M Microsen Series 130	1	0.5%	0.2 to 0.05 (63% of full scale)	1, 3 or 6"/hr (strip); 24, 8 or 1 hr rotation of drum (card)	Solenoid-operated pen-drive (Microsen) system; 25 sq in panel space; records on either 3" strip chart or 3" x 6" IBM card on rotating drum
Minneapolis-Honeywell ElectroniK Circular Chart Series 152 X and 142 X	1	0.25% or 0.03 mv for spans below 12 mv	24, 12 and 4 1/2	1, 4, 8, 12 and 24 hrs; also 7 days	12" chart has 4 5/8" calibrated width; concentric indicating scale has 28 5/8" length
Minneapolis-Honeywell ElectroniK Strip Chart Types 153 X and 143 X	1 to 20	1/5 to 3/8% depending on model	24, 12, 4 1/2, 2, 1, 1/2 and 1/4	1"/sec to 480"/hr, depending on model	12" chart has 122' length; adjustable span and suppression recorder has variety of span and zero combinations; extended range model switches five successive suppression steps automatically
Phoenix Precision SCR-500 Series	1 or 2	±0.25%	4	1 to 6"/hr	Model SCR-500 is 1-pen; SCR-500-R is ratio (x/y) recorder; SCR-500 XX is dual channel; SCR-500 XY is x-y recorder

TABLE 4—SELF-BALANCING POTENTIOMETER RECORDERS (Cont.)

MAKE	CHANNELS	ACCURACY	FULL-SCALE RESPONSE (SEC)	CHART SPEED	FEATURES
Photovolt Varicord Variable-Response Model 40	1	±0.5%	2	1 to 6"/min	Output/input characteristic (pen motion/input signal) adjustable by 12-position switch from quasi-logarithmic to logarithmic and beyond to translogarithmic
Sargent S-72150	1	0.1%	1.8	9 speeds, 1/3 to 12"/min.	40 ranges selected by switch; standard cell; chopper amplifier
Stoelting Model 22700	1	1%	2½, 1	1.8 to 12"/hr	Photoelectric chopper has no moving parts; mercury reference cell
Swartwout Autronic	1 or 2	½%	1	4"/min to 1"/day	Only 6" x 6 1/16" panel space required; 3" strip chart has 31-day record at 1"/hr
Varian G-10 and G-11	1	1%	2½ or 1	1"/min to 48"/hr	Mercury cell or continuous electronic (G-11) reference; 5" chart width; 15 lbs
West Marksman	1	0.2%	2 to 24	0 to 6"/hr	Fully transistorized
Westronics	1 or 2	0.5%	1	1"/hr to 60"/min	Requires only 9⅝" x 8½" panel space; continuous electronic standardization
Wheelco Series 2000 Round Chart		¼%			12" chart; 4⅝" calibrated width
Wheelco Series 8000 Strip Chart	1 ink; to 16 (multipoint)	¼%	1, 2, 4 and 15	1 to 600"/hr	11" width calibrated scale; printing cycle is 5 sec on multipoint

TABLE 5—X-Y RECORDERS

MAKE	CHART	ACCURACY	SPEED	FEATURES
Benson-Lehner Electroplotter S	40" x 40" flat	0.02" or 1 part in 2000	70 displays/min	Point plots graphs from cartesian-coordinate data; print mechanism has 13 symbols plus 3 decades of "flag" data
Benson-Lehner Electroplotter H	30" x 30" flat	0.02" or 1 part in 1500	24 line segments/min; up to 50 points/min	Plots lines by connecting points; input is digital data (coordinates)
California Computer	11" x 17" (drum)	0.005"	200 increments per sec (2"/sec)	Accepts positive or negative pulses; each axis moves in discrete 0.01" movements
Electro Instruments 100	8½" x 11" flat	0.2%	13"/sec (pen) 19"/sec (carriage)	Portable; 16 ranges from 0.5 mv to 50 volts/inch, both axes
Electro Instruments 200 215, 225	11" x 17" flat	0.2%	20"/sec (pen) 25"/sec (carriage)	Model 200 is for computer output recording; 215 has potentiometric input; 225 is general-purpose
Electronic Associates (EAI) Variplotter 205	30" x 30" flat	0.05%		Symbol printer has 12 symbols for 12 different plots; available with 2 writing pens and 2 timing pens
EAI Dataplotter 3033 B (LP)	30" x 30" flat	0.05%	50 point plots per min; line plot at 25 points per min	Converts digital point data to lines; plots 1 to 4 digits from punched cards, punched tape, etc.
EAI Variplotter 1100D, 1100E	10" x 15" flat	0.075% 0.015" (point)	20"/sec	Table-top design; keyboard input permits x-y plots of 4-digit data; can be used as computer readout
L&N 69950	10" x 10"	0.3%	1 sec (horiz.) 4 sec (vert)	Solenoid operated pen lifter; adjustable sensitivity; zero at center or extreme left
Librascope 200A, 200B	10" x 15" concave cylinder	0.1%	1 sec full scale, x or y	Model 200A has resistive (potentiometer) input; 200B has dc voltage input
Mandrel ER-90	8½" x 11" flat	0.75%	7.5"/sec (pen)	Portable table-top model; only 35 lbs.
Minneapolis-Honeywell Electronik	11" by 11"	0.5% (chart) 0.2% (pen)	24, 12, 4½ or 2 sec (pen); 12 and 4½ sec (chart)	Chart can be driven by null-balance or by synchro
Moseley Model 1	8½" x 11" drum	0.25%	1 sec full scale. x or y	Weighs only 35 lbs; integral time sweep available
Moseley 2A, 2S, 4, 6	11" x 16½" flat	Same	Same	Can be used as point plotter; Model 6 has automatic frame advance (100 charts/roll); S models have integral time sweep
Moseley 3, 3S, 5	8½" x 11" flat	Same	Same	Same
Scientific Atlanta Digital Plotter	11" or 16" flat	0.1%	2 points/sec, random	Point plotter; six symbols permit 6 simultaneous plots; binary or decimal coded inputs
Tally Register 201	11" wide strip (as long as desired)	0.025"	8 points/sec, random	Point plotter from digital (25-bit binary-coded decimal) input; four symbols

TABLE 6—OPERATION RECORDERS

MAKE	TECHNIQUE	CHANNELS	FEATURES
Alden Group A	Styli on Alfax (electro-sensitive) paper	2, 30, 60, or more	Rolls for ¾ hr to 8 days
Brush RE-3610-00	Electro-styli	100	12" x 500' charts; 8 chart speeds; 1 ms response permits 500 signal changes/sec
Curtis-Wright 819	Ink; solenoid-operated pens	4, 8, 16	Made by Metrawatt A. G.; six chart speeds
Electro-Medical Garceau Chronograph	Electronsensitive	6 to 100	Six-trace model has 1" wide tape; nine tape speeds from 2½ to 200 cm/sec; others from 1 mm/hr to 25 m/sec
Ess Instrument	Solenoid-operated ink pens	1 to 5	12" round chart; 10 operations can be recorded by double action of the 5 pens
Esterline-Angus	Ink, electromagnetic-operated pen	to 20 in single case; to 40 in twin case	Uses maker's standard charts (6" x 103') and drives (speeds from ¾"/hr to 3"/sec); will follow 10 on-off cycles/sec
Gorrell & Gorrell Strip Chart	Stylus on waxed or electro-sensitive paper	12 to 36	Portable or wall models; max response is 8 operations/sec
Gorrell & Gorrell Drum Type	Waxed paper chart on vertical drum	1 or 2	6" x 14" chart; record is from 160 min to 40 days; small "Record Timer" model has horizontal drum
Larson	Electrosensitive	to 30	1 ms response time; 7" x 100' chart; 10 ma stylus current; ½"/hr to 10"/sec chart speed
Lindly Lind-Recorder	Styli on electro-sensitive paper	44, 68	Paper speeds from 2 to 32"/hr
Mandrel	Electrosensitive	to 40	Uses standard ER-20 strip-chart model with speeds from 100 mm/sec to 10 mm/min, and others
Sa born	Hot Stylus deflected 1.5 mm by solenoid in 10 ms	4, 8, 16, 24 or 32	Uses "150" and "350" series charts and drives (speeds from 0.25 to 100 mm/sec)
Sheffield Monitorecord	Pressure-sensitive paper	to 14	5" strip chart driven at 5"/sec or 1"/sec, other speeds available; accuracy to 1/60 sec

TABLE 7—MULTIPLE-STYLI RECORDERS

MAKE	TECHNIQUE	FEATURES
Radiation Radicorder	646 styli on 0.018" centers; Teledeltos paper	Chart speeds from 0.3 to 100"/sec; 12" x 12" window for "real-time" viewing of record
Tally Model 314	512 (or fewer) styli; electrolytic writing electroplates iron from electrode to Faxpaper; 50 styli per inch	Accepts binary input data; relay tree guides data to single stylus; graphs are series of time-spaced dots. Response is 50 points/sec for each variable; 12 variables can be plotted simultaneously across 14" plotting head. Chart speeds from 0.5 to 10"/sec

TABLE 8—SWEEP RECORDERS

MAKE	TECHNIQUE	FEATURES
Alden Group B	Rotating cylinder (3600 rpm) with helixes; Alfax electrosensitive paper	Moving endless-loop electrode minimizes erosion; chart widths of 2", 5", 8", 11" and 19" available; unit comprises helixes on drum and electrode; not a complete recorder.
Consolidated Avionics Verigraph	Rotating cylinder (3600 rpm) with helixes; electro-sensitive paper	10" wide chart; no overshoot or undershoot.

TABLE 9—RECEIVER RECORDERS

MAKE	FEATURES
ATC Atcotran	Linear variable differential transformer input; strip or round chart; ¼% accuracy; full-scale pen deflection in 2, 6 or 10 seconds; 1 to 16 channels
Bailey	Differential transformer or bridge input; ¼% accuracy; 1 or 5 second pen travel; 1 to 4 channels
Fischer & Porter 1102-G-02	Operates from flow transducer which comprises one half of an a-c resonant impedance bridge; 12" circular chart
Leupold & Stevens CAV and PAV	Operates from synchro transmitter for water level, gate position, etc. 10" x 25-yd strip chart
Schaevitz	2-pen strip chart; linear variable differential transformer (LVDT) input

TABLE 10—SPECIAL-PURPOSE RECORDERS

MAKE	PURPOSE
Airborne Instruments Laboratory Type 116R	Polar-pattern recording for electromagnetics, acoustics, thermal distribution, antenna radiation
Baldwin-Lima-Hamilton	Strain recorders
Barry T/Plotter	Plots vibration transmissibility curve on strip chart during vibration test cycle
Bludworth ES-130	Hydrographic survey using barium titanate transducer (200 to 220 kc) with depth range to 245'
Edin 9101	2-channel weld analyzer
Electric Tachometer Tetco R-500	Rate recorder records rate at which shafts or production lines move
Gilmore Segmental Model 156	Up to 192 channels individually plotted on separate 5½" x 6" graphs
Hallikainen-Shell Thermograf	Records increments of (not absolute) temperature
Industrial Instruments Type RQ	Electrolytic conductivity recorder; battery operated, transistorized
Rantec HSR-1 Log-linear	Plots logarithm of input voltage as ordinate and angular position of synchro as abscissa on 8½" x 11" paper; useful for radiation patterns, etc.
Southwestern Industrial ARP—1 Audio Response	Plots frequency-response curves in 20-20,000 cps range in one continuous sweep on 40-db range logarithmic chart.

The high cost of instrumenting facilities where large numbers of pressures must be measured often prevents the test engineer from obtaining all of the data he needs at useful accuracies. A pressure scanning system using one high-speed high-accuracy transducer and a scanner can accurately measure large numbers of pressures varying over wide ranges.

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Pressure Scanning System

IN TESTING of aircraft engines and missiles a large number of pressures must be measured, most of which can vary over large ranges. For example, an inlet pressure to the combustion chamber in a jet engine may vary from 1″ to over 70″ Hg absolute, depending on altitude, speed, etc. To measure pressures with satisfactory accuracy over large ranges is a problem confronting the instrumentation engineer in other fields also.

Two Basic Approaches

Two approaches are possible: (1) a system of multiple transducers of conventional accuracy with manual or automatic switching for selecting the proper transducer for the pressure being read, or (2), a single high-accuracy high-speed transducer, which will scan the pressure signals and produce the desired accuracy over the entire range to be measured.

The first approach has some advantages if the accuracy requirement and pressure range are not severe. However, for most applications the complications of multiple transducers, plus their calibration, and switching (particularly if automatic), raise the cost and maintenance problems. In addition, if programmed or transient changes in pressure occur over a large range, automatic switching is required, introducing switching transients into the reading—or a single full-range transducer must be used, with attendant low accuracy for the lower readings.

By contrast, although a high-accuracy transducer is more expensive than one of lower accuracy, the second (single-transducer) system is much simpler and may be cheaper than the multiple transducer system. In addition, it can be specified on the basis of the programmed or transient requirements alone. The advantages of a single, reliable calibration, recommends high-accuracy pressure transducers for many applications in testing and process control. To be most useful the system must be capable of measuring pressures at a rate of at least one per second.

FIG. 1. ELEMENTS of the system.

The following tests of a pressure scanning system comprising a Hagan Model A-2 transducer and a Model SP-101A Giannini pressure scanner and accessories (Fig. 1) were to determine the maximum practical speed at which the pressures could be scanned and still obtain readings to 0.1% of the actual pressure.

The System

The system block diagram is shown in Fig. 2. The Giannini SP-101A scanner is a motor-driven 12-position single-pole pressure switch. Twelve inlet ports are connected in sequence to the single outlet port, and the outlet is vented to a separate connection between adjacent positions (whereby the transducer connected to the outlet port can be vented to atmosphere or vacuum between every reading). A separate control unit is available as a manual master control for positioning the scanner to the desired position. The scanner itself runs as a slave, and incorporates a switch for remote indication of its actual position at any time. The internal volume of the scanner between switch and outlet port is 0.01 cu in, and it is capable of operation up to 350 psi. Its free running speed is 20 rpm, but the manufacturer's stated time

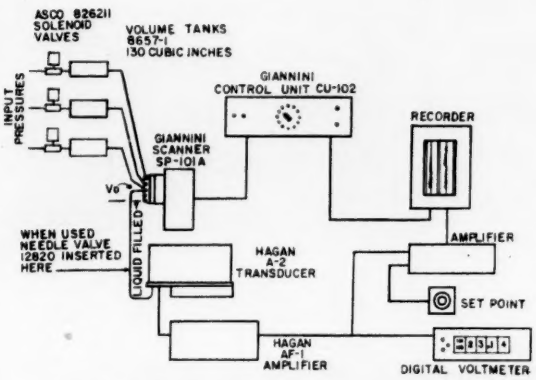

FIG. 2. PRESSURE scanning system.

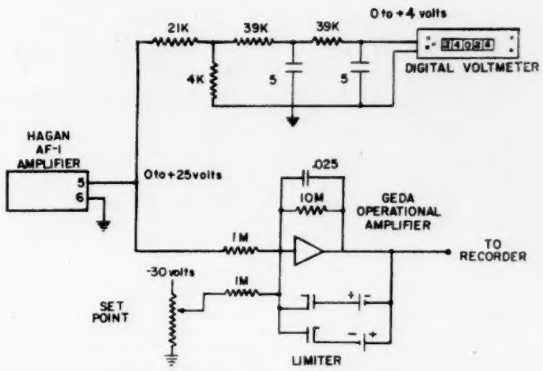

FIG. 3. RECORDING and indicating circuit diagram.

for one full step is 450 milliseconds, with the port starting to open after about 200 milliseconds.

The Hagan Model A-2 transducer, calibrated for 40" Hg gage, was operated with a Model AF-1 amplifier arranged for 0-25 volt output. An attenuator and filter were introduced between this output and a Non-Linear Model 451 Digital Voltmeter so that the voltmeter reading was equal to the input pressure in inches and hundredths of an inch of mercury.

A disabling switch on the DVM permitted taking readings at will, while eliminating spurious interaction of the DVM on the precision recorder.

The 0-25 volt transducer output also was summed with an equal and opposite (set point) voltage at a stabilized operational GEDA amplifier with a gain of 10 (Fig. 3). Further amplified, this difference voltage produced a full-scale record of about 1% of the transducer full-scale input for observing the time response and accuracy of the over-all system. A lagging time constant was incorporated in this operational amplifier for damping the high-frequency noise output from the transducer. A limiter also was incorporated to prevent saturation and damaging the recorder when the transducer was switched to a different pressure. An adjacent channel of the recorder was connected to a synchronizing signal from the Giannini scanner control unit to permit time comparison of scanner position and transducer output.

Tests

Two types of tests were made—(1) with input pressure connected to scanner ports from an infinite-volume source (pressure regulators) through short tubing sections and (2) with input pressures trapped in volumes with solenoid valves, then scanned. Since the trapped pressure will decrease in the volume tank when connected to the transducer volume by the ratio of those volumes, the transducer volume was reduced by filling it with an inert liquid. Optimum response was achieved by using both a restriction in the liquid-filled transducer connection and an electrical filter in the output.

In the first test, various pressures were set at each of three inlet ports with high-volume stable pressure-regulators. The transducer volume (2-3 cubic inches) was air filled. The scanner was set to a position, and the pressure at that input position was measured with both a mercury manometer and the DVM. The set point was adjusted to center the recorder pen on its chart. Then the scanner was moved to the immediately preceding position. The recorder chart was then started, and the scanner control moved one step to the point in question. In all cases the scanner vent was bled to atmosphere.

For the second test the equipment was connected as shown in Fig. 2. Each input was connected through a tight shut off solenoid to a 130-cu-in volume tank (8657-1) and thence to its respective scanner inlet port through a short (8") section of ¼" O. D. tubing. The transducer was connected to the scanner outlet port with approximately 3 feet of ¼" O. D. tubing.

Results

Tests at a scanner speed of about 25.6 rpm indicated an estimated one-step time of about 250-400 milliseconds. As relays are used in establishing the scanning cycle, it is felt that the scanning time for one step probably can be decreased with an improved type of master control. Since this scanner control must be tied into the readout equipment for proper synchronizing, it is felt that this can be done.

The results show that a pressure can be measured to within 0.1% of its actual value within 200 milliseconds of the time the scanner reaches its final position. With a slight increase in hydraulic damping this time can be decreased to 0.1 second. Using a 400-millisecond scanning time for the scanner, output stabilization times of 500 to 600 milliseconds are indicated. Using the estimated scanning time for the scanner with either improved control or running free, output stabilization times as low as 350 milliseconds are possible.

These figures indicate that reading times, depending on the speed of the digital conversion equipment used, of 0.75 or 1 second can be achieved. Commercially available conversion equipment have conversion speeds of about 50 to 350 milliseconds per reading.*

*Kybernetes and Epsco systems, and Nonlinear Systems Model 312 digital converter and Model 1400 DC voltmeter.

Commutation Switch Developments

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Here are the basic sampling-switch considerations that instrument engineers must consider, and improvements in the state of the art that may be useful to systems design engineers. Low- or high-level signals now can be switched at high speeds into low- or high-impedance loads.

IN MANY process applications and in most conventional airborne telemetering systems an electromechanical, time-sharing switch is a critical component. The performance of the switch can place serious limitations on the accuracy and reliability of the over-all telemetry system. In many cases it contributes seriously toward limiting the scope of the system and may add to its complexity. It is important that designers, manufacturers, and users of telemetry systems be familiar with the performance that they can expect from switches so that the switch will not be a limiting factor. It is equally important that designers take maximum advantage of improvements in switch performance as they become available.

Electrical Noise Considerations

For sampling switches, the three most important general performance characteristics are *electrical noise, service-free operating life,* and *performance under ambient conditions.* Let us first consider the importance of electrical noise as it affects performance and application of the switch.

Electrical noise can be considered as being of three broad types:

1. Noise associated with high-impedance circuits.
2. Noise associated with low-impedance circuits.
3. Noise caused by thermal emf and contact bounce at make and break (independent of impedance).

Classification of noise sources on the basis of impedance is of interest to the systems engineer because the measuring circuits in which he desires to utilize the switch usually fall into one of these categories. High-impedance circuits are generally considered circuits of about 10,000 ohms or more; and low-impedance circuits are those below 1,000 ohms. Strain-gage and thermocouple-type devices inherently have both low impedance and low signal outputs and generally are best operated into low-impedance loads. On the other hand, potentiometric output devices and some bridge circuits are usually operated into high-impedance loads to maintain linearity and sensitivity. Spurious commutator noise imposes limitations on switch applicability to these transducers in telemetry or sampling systems.

As seen in Fig. 1, different switch design parameters are involved when considering high- and low-impedance circuit applications. For *high-impedance loads,* electrostatic and electromagnetic shielding are important in avoiding both pickup from the driving motor circuit and cross-talk from other circuits within the switch which may be operating at a relatively high voltage level. The effect of capacitance in various paths of the switch segments is also important because it can cause a serious rise-time or decay-time constant at the instant of make or break. Pickup from the motor supply can be effectively reduced by bringing the motor leads to the switch through a separate plug or header. This recommendation is worth serious consideration in switch header specifications because pickup levels in the order of 25 millivolts have been encountered along the unshielded pin length within a hermetic plug assembly when motor leads were taken through the same receptacle as the signal leads.

In *low-impedance circuits,* dynamic contact resistance variation at the brush-commutator surface is

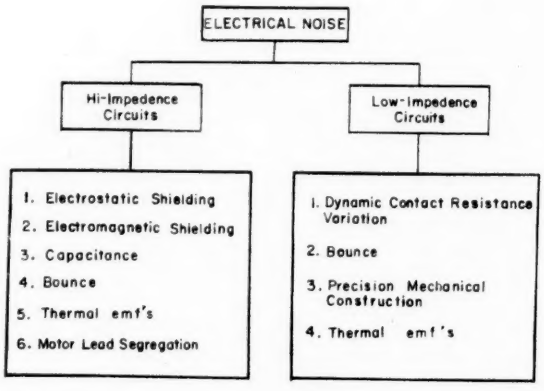


FIG. 1. CLASSIFICATIONS of electrical noise.

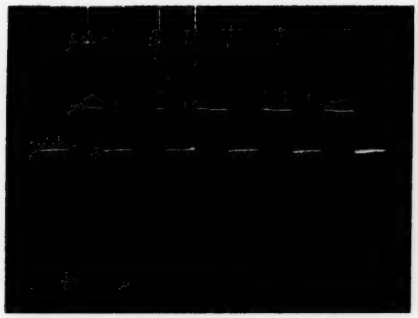


FIG. 2. SWITCHING A LOW voltage (1 mv) into a high impedance (1 megohm).

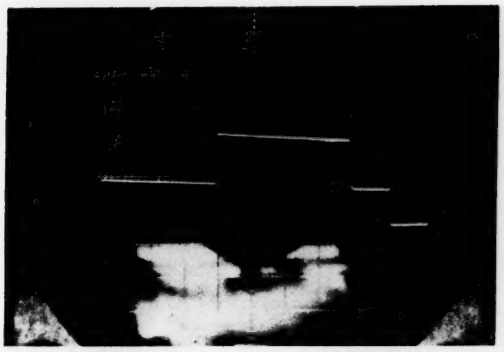
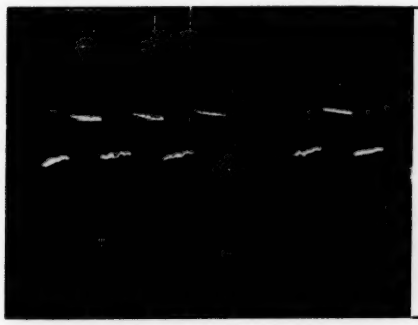


FIG. 3 SWITCHING A high-level (100-mv) signal into 10,000 ohms.



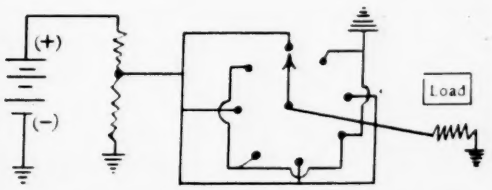


FIG. 4. SWITCHING A low-voltage (100-uv) low-impedance signal (strain gage or thermocouple) into a 100-ohm load.

perhaps the most important factor contributing to electrical noise. A design factor to be considered in maintaining low dynamic contact resistance variation is the precision of the mechanical construction which insures accurate contact of the brush and commutator at all points in the switching cycle. Properly damped, multifingered brushes statistically reduce the probability of noise pulses due to surface contact resistance variations. Obviously, the choice of materials for the brush and the slip ring is critical to this parameter. With good quality control and attention to the above details, this dynamic resistance variation has been reduced to about ± 0.015 ohm.

For circuits of *any impedance*, brush bounce and thermal emf's (self-generated within the switch) must be taken into account. Bounce has been virtually eliminated by a new brush design which features counterbalanced construction, jewel pivots, and exceptionally low mass and spring constants. This is a significant improvement since the presence of bounce reduces the available sampling time. Auxiliary gating of the sample pulses can be eliminated with a resultant improvement in signal-to-noise ratio and an attendant reduction in system complexity. Self-generated thermal emf voltages have been reduced to less than 20 microvolts by these features and through proper circuit design (see Fig. 6).

Examples of the degree to which present-day designs are accomplishing the desired results are shown in Figs. 2 to 6.

Fig. 2 shows a typical oscilloscope presentation of a commutator switching a 1-millivolt signal into a 1-megohm load. Switching of this relatively low signal level into high impedance is an indication of the success with which internal electromagnetic and electrostatic shielding has been made effective, as well as an example of freedom from bounce on the make and break portions of the pulse.

Fig. 3 shows an example of conventional switching of relatively high level signals, approximately 100 millivolts, into 10,000 ohms. The time scale is one millisecond per division, and a second signal has been superimposed upon the first. It should be noted that this super-position means that four brushes are operating in series, and bounce in any one of the four would be immediately visible.

A typical circuit for testing performance into low impedance loads is shown in Fig. 4. A 100-ohm load is generally considered a lower limit for strain-gage work and for some types of thermocouple pickups. Fig. 4 shows the extent to which low-level low-impedance loads can be switched successfully. In this case a 100-microvolt signal is being switched into 100 ohms. The upper bars indicate the signal, and the lower bars represent the grounded portion of the signal. (The slight taper to the record is caused by the use of an a-c preamplifier.) The signal is clear for such a low signal level and noticeably free of either bounce or "grass" which would be expected if there were any appreciable dynamic resistance variations.

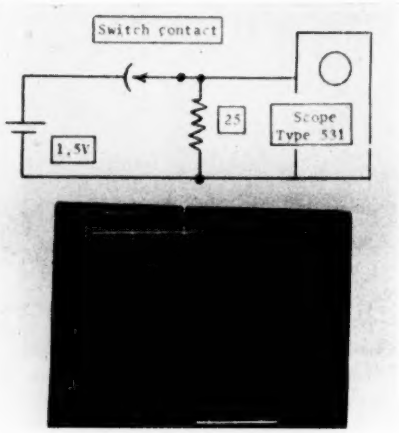


FIG. 5. SWITCHING A high current (60-ma) at 25-ohm impedance. This low-impedance network requires extremely low brush resistance for clean switching characteristics.

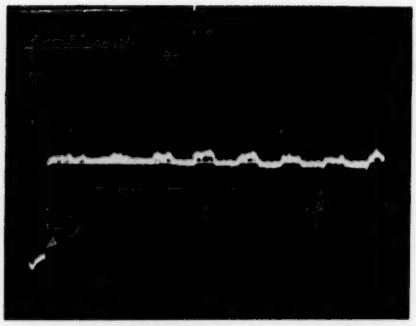


FIG. 6. SAMPLING A thermocouple output. The pulse at the left hand side of this trace shows a 250-microvolt signal (generated in a chromel-alumel thermocouple) switched into a 2000-ohm load.

Fig. 5 shows switch performance for a load impedance of only 25 ohms with the switch commutating 1.5 volts at 60 ma. For thermocouple work, tests have been made with chromel-alumel couples working through the switch into 2,000 ohms. Noise level, as shown in Fig. 6, due to the switch itself, corresponded to a temperature error of about 1°F. This particular test was made on a switch ring which had already seen 200 continuous hours of service-free operation.

The examples given in these figures indicate fairly clearly that mechanical switching has reached a point where very low-impedance circuits, as well as high-impedance circuits, can be handled successfully for telemetering and multiplexing purposes. All the data presented in this section has been taken at switching speeds of either 10 or 30 rps (600 or 1800 switchings per second), using switches that have had from 200 to over 1000 hours of service-free life. Expanded time scales have been used to examine leading and trailing edges, and measurements have shown a leading edge rise time of approximately 5 to 8 milli-microseconds and complete absence of bounce within 12 microseconds of the leading or trailing edges.

Service Life and Reliability Factors

Fig. 7 shows the construction features used in IDL switches which contribute to reliability. The brush assemblies are of jewel-pivoted, counter-balanced construction using special metal alloy brushes working on precious-metal internally-segmented cylindrical commutators. This design, combined with surface finishes on the commutator of 2 or 3 microinches contributes to the low brush wear rates as well as the low noise and bounce-free performance described in the previous section.

Successful operation at extremes of −55°C and +100°C calls for extreme care in bearing fits, bearing lubrication, control of differential thermal expansion, and avoidance of temperature differences at points which might contribute to thermal emf noise.

The cylindrical commutator construction is held in a cyindrical "barrel" under high axial loading which provides extremely rigid commutator segment location up to 100 g. Balancing of the pivoted brush assembly makes possible resistance to vibration and shock without excessive contact pressures. Conventional switch configurations of this type will withstand shocks in excess of 30 g and vibration at 10 g to 500 cycles. Special designs will perform to 2,000 cycles. Centrifuge tests have shown that sustained accelerations of up to 75 g have no effect on the timing or noise performance of high-speed mechanical switches of the design described.

Problems of dust, altitude, and humidity have been overcome by hermetic sealing of the entire unit.

Conclusion

Fig. 8 shows representative switches based on design considerations discussed, varying from two-wafer telemetry units to six-wafer special-purpose units. This article is intended to illustrate to systems engineers that the state of the switching art has advanced to the point where reliable, service-free, long-life operation is possible under adverse ambient conditions while switching either low- or high-level signals into either low- or high-impedance circuits. This type of signal switching can now be made available in production units at switching rates as high as 900 pulses per second.

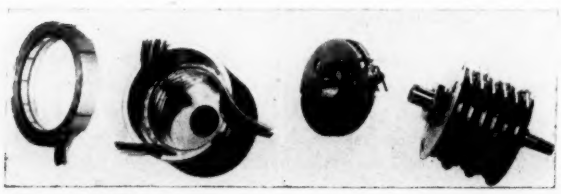


FIG. 7. TYPICAL commutator and brush configurations.

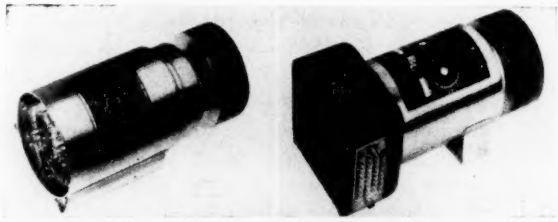


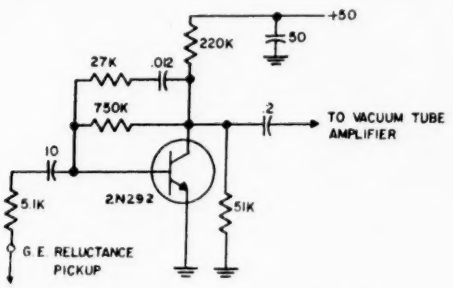
FIG. 8. TYPICAL case configurations.

ELECTRONIC CIRCUITRY

MILTON H. ARONSON and CHARLES F. KEZER

TRANSISTOR PREAMPLIFIER FOR VACUUM-TUBE AMPLIFIER

Output of magnetic phonograph cartridges is often only a few millivolts: hum pickup in vacuum-tube amplifiers used with these cartridges can be troublesome. This transistor amplifier can be used ahead of the vacuum-tube preamplifier, increasing the signal level with respect to the hum level of the first vacuum-tube stage. It also provides proper frequency compensation for recording characteristic.



Required low-frequency boost is obtained by voltage feedback from collector to base. As the reactance of the 0.012-uf capacitor is negligible at all but the low frequencies, negative feedback is reduced at low frequencies, providing the rising response needed as frequency decreases. A roll-off of high frequencies is also required to compensate for preemphasis of these frequencies during recording. High-frequency rolloff is obtained with the 5.1K-ohm series resistor on the input in combination with the inductance of the magnetic cartridge. (Although 5.1K ohms is the proper value for the GE magnetic cartridge, a different value may be required for other cartridges.)

The 50-v dc supply voltage can be obtained from a voltage divider across the vacuum-tube-amplifier power supply.

Voltage gain at 1 kc: Approximately 3.

Output impedance: Not important.

Frequency response: RIAA standard recording characteristic.

Max. input signal: 10 mv.

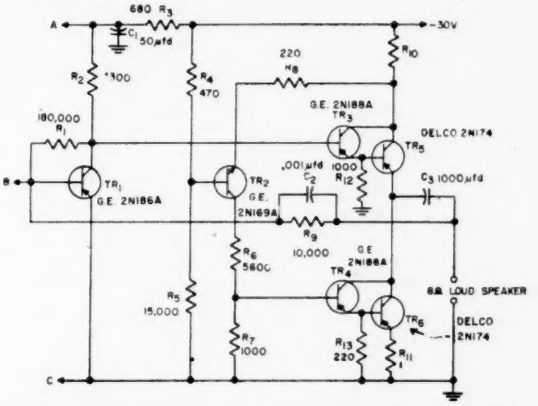
Power supply: 50 v dc at 100 ua.

Source: *Transistor Manual*, 2d Edition, General Electric Co., Semiconductor Products, 1224 W. Genessee St., Syracuse, N. Y.

TRANSFORMERLESS TRANSISTORIZED A-F POWER AMPLIFIER HAS 7-W OUTPUT

As the output transformer seriously limits performance of highfidelity amplifiers, many circuits have been devised to eliminate it. Practical vacuum-tube circuits, however, must use many tubes in parallel to provide the high currents necessary for direct driving of low-impedance loudspeakers. The advent of power transistors opens new possibilities because transistors are inherently low-voltage high-current devices.

Two power transistors are used in the outpt stage of this transformerless, phase-inverting pushpull amplifier to provide 7 watts output at 0.5% rms distortion. The input transistor TR_1 (with common-emitter hookup) drives the emitter-follower TR_3, which is direct-coupled to the output emitter-follower TR_5. Transistor TR_6 forms the emitter return path for TR_5, and delivers half the output power, providing pushpull operation. TR_6 is driven by transistor TR_4.



The phase-inverted signal to drive the base of TR_4 is obtained from the 1-ohm resistor in the collector circuit of TR_5. Transistor TR_2 is used to direct-couple this phase-inverted signal to the base of TR_4. (Transistor TR_2 could have been omitted and a capacitor used to provide ac coupling; ripple from the power supply, however, would appear practically unattenuated at the base of TR_4, producing hum in the output.) A second advantage of the circuit shown is that dc stability is improved because any change in the collector voltage of TR_5 is amplified and appears at the base of TR_4 in such polarity as to return the current in the power transistors TR_5 and TR_6 to the correct value.

Resistors R12 and R13 increase the bias current in TR_3 and TR_4, allowing power transistors TR_5 and TR_6 to be driven to full output at high audio frequencies where the current gain of power transistors begins to decrease. Reduced distortion and lowered output impedance are obtained by negative feedback from the output via R9 and C2 to the input.

A preamplifier-driver for driving this power amplifier will be described in the future.

Power output: 7 watts into 8-ohm load.

Distortion: 0.5% rms.

Output impedance: 0.3 ohm.

Frequency response: ±0.1 db, 20 cps to 20 kc.

Input impedance: 300 to 500 ohms.

Input level for 5-w output: Approx. 25 mv.

Power supply —30 v dc at 600 ma.

Source: *Transistor Manual*, General Electric Co., Semiconductor Products, 1224 W. Genessee St., Syracuse, N. Y.

ANOTHER NEW LESLIE PRODUCT

ADJUSTABLE PROPORTIONAL BAND Floatless LIQUID LEVEL CONTROL

...with adjustable level ranges up to 0-200"

Here is a new differential pressure-type liquid level control pilot that combines the wide adjustable level ranges in the table shown below with a 2-20" or 7-25" adjustable proportional band.

ADJUSTABLE LEVEL RANGE — INCHES	ADJUSTABLE PROPORTIONAL BAND (INCHES, H_2O)	CONTROL PILOT TYPE
0-40 or 0-87	2-20	LAP
0-30 or 0-91	2-20	LABP
0-200	7-25	LAUP

Maximum Static Pressure — 300 psi

One Knob — Easy Adjustment

A single knob adjustment quickly sets the proportional band where you want it, even while the system is in operation. The liquid level is maintained constantly within that band until you re-set the control pilot for new conditions.

Applications

Leslie-Level-Matic Control Pilots are used in either open or pressurized vessels to control the level of virtually any liquid including water, gasoline, oil and chemical solutions. The new control pilot is particularly useful to maintain constant levels where there are high flow rates through vessels with small cross sectional areas.

Float Cages Eliminated

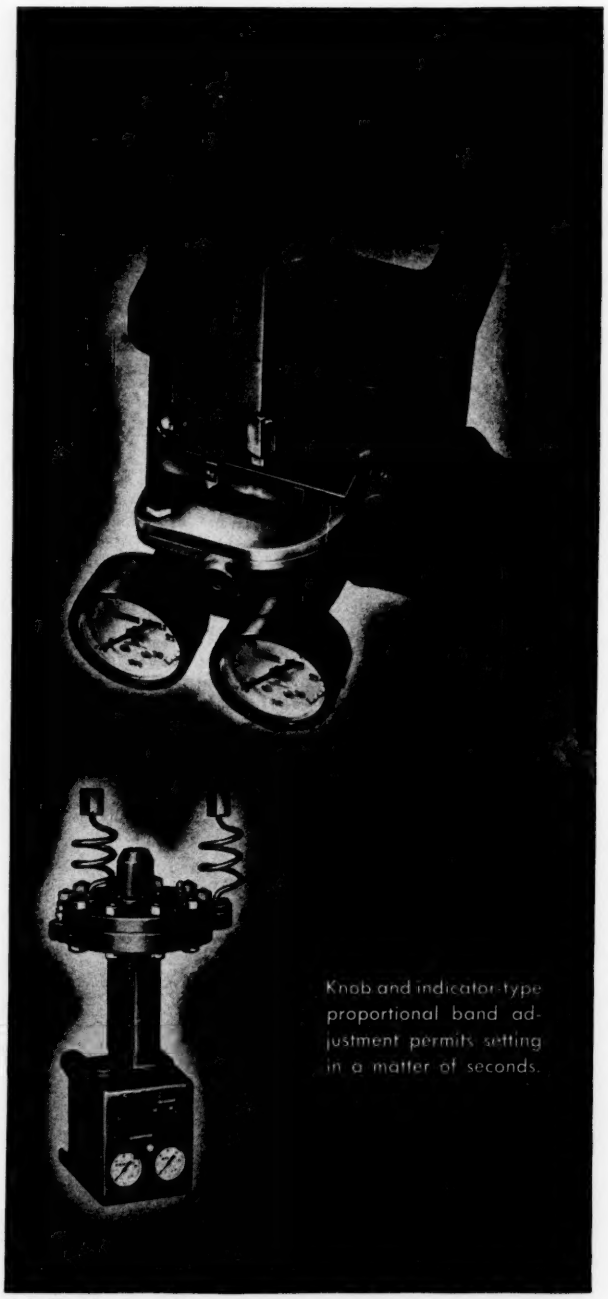
There are no floats or cages needed for Leslie-Level-Matic Control Pilots, and no torque tube seals, stuffing boxes, or thermohydraulic systems. All of the primary control elements are in one place and may be installed with a fraction of the effort and cost required for displacement-type controllers.

Vibration-Proof, Dependable

All of the dependability factors for which Leslie products are so well-known are incorporated in this new control pilot, as well. Rugged, accurate, stable — it is unaffected by normal vibration or turbulence.

More Information

Send for Engineering Data Sheet describing this new Control Pilot and outlining its principle of operation.



Knob and indicator-type proportional band adjustment permits setting in a matter of seconds.

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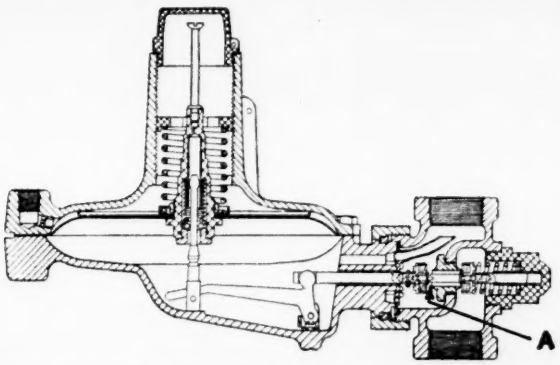

Fig. 12-1. Mechanical latch causes auxiliary valve-disc to shut off flow of gas in event of excess downstream pressure or failure of supply pressure.

CHESTER S. BEARD
General Controls Company

Automatic Shut-off Valves for Gas and Oil Transmission Lines

IN CHAPTER 11 many methods and types of valves for emergency shut-off were discussed. The equipment was for use on fuel lines or for heat exchange systems. The systems, in most cases, come under the jurisdiction of the approval agencies and local ordinances and the valves were primarily designed for these applications.

Another important group of valves is used by the gas industry for emergency control in transmission and distribution lines and in oil field gathering systems. Although the application is specialized, the manner of obtaining emergency operation is basic and uses a combination of bodies, actuators and pilots.

Basic Problems

Problems confronting the gas industry have many unique features which place them apart from many other industrial considerations. The gas industry operates under laws and franchises which require a continuance of service and stipulates safe conditions. Decisions as to when to shut down a line or when to relieve to atmosphere become more difficult when one considers a few of the complications.

On first thought, protection of a system from over-pressure could consist simply of relieving gas to atmosphere. This, however, poses a safety problem, particularly when the release may of necessity be in a densely populated area. Release of large quantities of gas is costly and may even constitute breach of contracts which stipulate maximum rates of usage. Excessive release may also upset pressure conditions throughout other parts of the distribution system.

Basic Techniques

A mechanical shut-off feature is incorporated in the valve shown in Fig. 12-1. Used primarily as a house service regulator, the flow of gas is entirely shut off either if the downstream pressure should exceed the regulator setting by a predetermined amount or if a failure or near-failure of supply pressure occurs. The lever which links the diaphragm to the inner valve is coupled to the diaphragm by means of a specially designed mechanical latch. When the mechanical coupling at point "A" is interrupted due to excess pressure under the diaphragm, the auxiliary valve disc in the body of the regulator moves tightly against the back side of the regulator orifice and thereby interrupts the flow of gas. Resetting requires removal of the regulator closing cap and pulling the reset stem upward.

When release of gas is selected as a measure of protection against over-pressure, specially designed relief valves (described in Chapter 11) are used. These relief valves are designed so that they act as back-pressure regulators for conditions of small over-pressure and open wide when over-pressure becomes excessive.

Another approach is the use of a relief valve with separate controls for opening and closing. In such valves the speed and setting for opening and closing may be set accurately. Thus the closing point is not subject to blowdown-ring effects and may be held close to the opening pressure.

Relief of a low-pressure line can be regulated by using piloted line pressure (Fig. 12-2) on a large diaphragm. Under normal line pressures the pilot regulator releases pressure from the under (valve) side of the power diaphragm to atmosphere while applying line pressure to the opposite side of the diaphragm, thus closing the valve. Increase of line pressure above the spring setting of the pilot regulator positions pilot valves to release pressure above the diaphragm so that pressure which has been directed below the diaphragm, plus the unbalance across the swing check valve, will open the main relief valve.

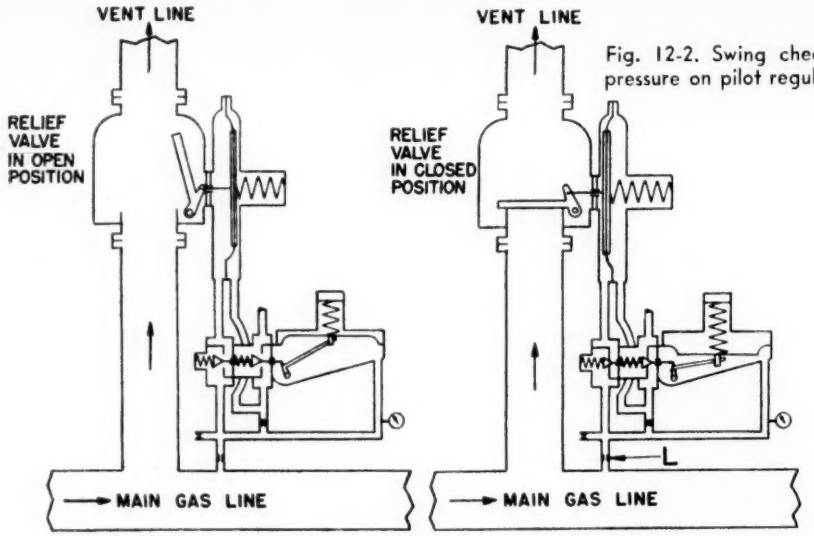

Fig. 12-2. Swing check valve is positioned by varying pressure on pilot regulators.

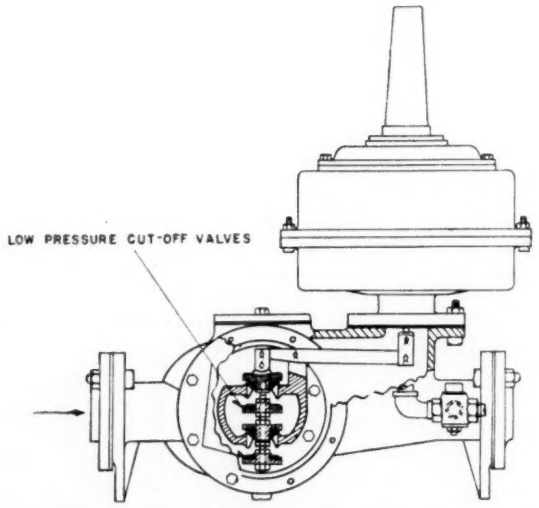

Fig. 12-3. Regulator must be manually opened if low pressure cut-off valves close due to decrease in line pressure or valve going wide open.

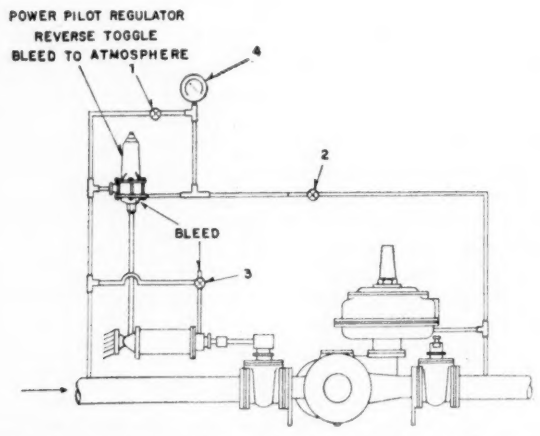

Fig. 12-4. Isolating plug cock is operated by piston actuator.

Complete Shut-down Involves Considerable Service

Equipping a pipe system with valves for complete shut-down involves more than safety considerations. Complete shut-down of a gas line furnishing a town or area nearly always requires that the service department must send out men to each customer and shut off all service and pilot lights. Upon restoration of gas supply another call must be made to check out all pilot lights. Nevertheless, there are conditions of either excess or abnormally low pressure which justify shut-down of a supply line.

High-capacity regulators can accomplish shut-off at abnormally low pressure. Fig. 12-3 shows a valve in which a second set of seat discs closes in event of low pressure on the diaphragm, complete rupture of the diaphragm, or the valve going wide open. The valve can be opened only by pulling up on the diaphragm stem.

One of the plug cocks installed to isolate the pressure regulator can be operated by a cylinder actuator (Fig. 10-4). The plug cock is opened by use of line pressure through the three-way valve (3). When the plug cock is open, the bleed valve is turned to vent the piston. Upon abnormal pressure increase on the controlled side of the regulator, the pilot will open to inject line pressure in the cylinder so as to shut the line plug cock.

Fig. 12-5 shows a means for obtaining positive shut-off without danger of reopening unless manually reset. When the line pressure (which is piped to the top of the diaphragm) reaches a low value, the latch connecting the two independent weighted levers disengages itself from the upper lever allowing the lower lever to move the inner valve onto its seat. Use of weights for setting the closing pressure has the advantage of allowing continued movement of the diaphragm as the line pressure on top of the diaphragm reaches the set point. Use of a spring for the setting would require increase of pressure above the set point to obtain sufficient movement to cause the tripping action. A similar 2-lever-and-latch arrangement closes the valve upon excessive increase of pressure on the diaphragm.

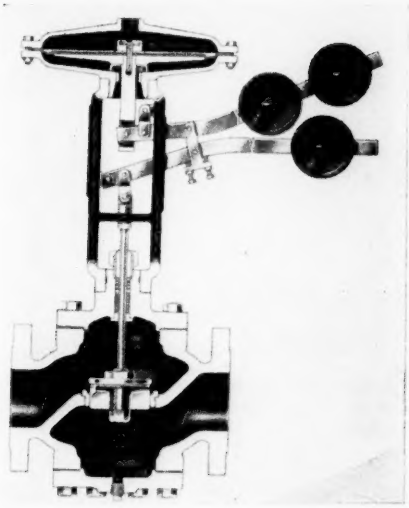

Fig. 12-5. Decrease in pressure on the diaphragm changes relation of weight arms, releasing latch and allowing lower weight-loaded arm to close valve.

Shut-off Procedure

Emergency shut-off of transmission pipelines and the isolation of compressor stations is a common problem. These functions are accomplished by application of the line valves and pilots with methods of sensing an emergency condition.

Sensing of differential is the method used to determine rate of pressure drop in a *pipeline*. For this purpose a capacity chamber is connected to the main line through a small branch in which an orifice is installed. On normal increases and decreases in line pressure, the pressure in the chamber will follow the line pressure. When a major break in the line occurs, the decrease in line pressure will be so rapid that an abnormally high differential is created across the restriction orifice. This differential, as sensed by an instrument, is used to cause a pneumatic or electric impulse to operate emergency valves. Success of this method depends on correct evaluation of the differential as to abnormal versus normal pressure changes.

The valves of a *compressor station* can be sequenced to isolate and purge the station piping upon sensing unsafe operating conditions. These conditions may be abnormally high or low pressures, incorrect differential between intake and discharge lines, overheating of engine bearings, or evidence of fire. Operation of the shut-down valves may be by remote-manual methods (by the local operator) or by the dispatcher upon recognition of the unsafe condition (as shown by alarm lights or telemetered readings on his instruments).

Dependable power is required for these emergency units. Gas pressure at the maximum pressure attained in the lines can be stored in underground chambers. A check valve in the line between the chamber and pipeline traps this pressure for storage. Power for electrical systems must be from batteries or some source not related to normal operation.

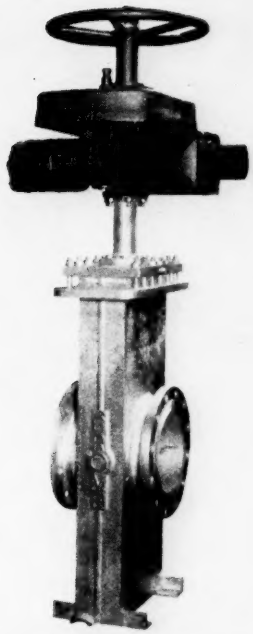

Fig. 12-6. Motor-driven gear actuators may be applied to gate, globe or plug valves.

Electric actuators (Fig. 12-6) have the advantage of nearly unlimited power, controlled force for closing the valve, hammer blow for opening, and versatility in application, to control systems.

A pneumatic rotary motor is used extensively for powering the geared units of the type shown in Fig. 12-7. The self-contained electrohydraulic actuator shown in Fig. 12-8 develops high stem forces for large valves, with fast closing action under emergency conditions.

Universal acceptance of the plug cock for gas service has brought about the design of actuators particularly adapted to this service. Rotation of fins in

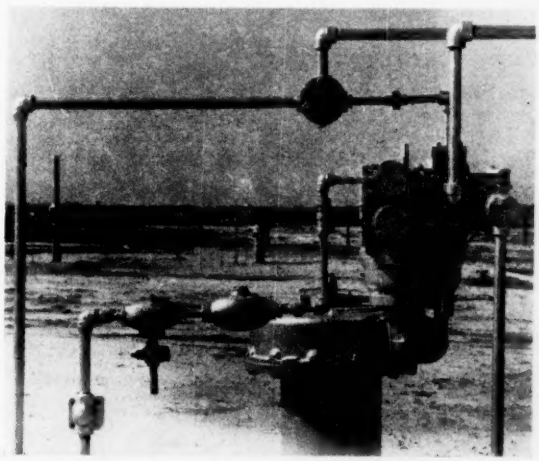

Fig. 12-7. Gas from transmission line operates the rotary gas motor of geared actuator.

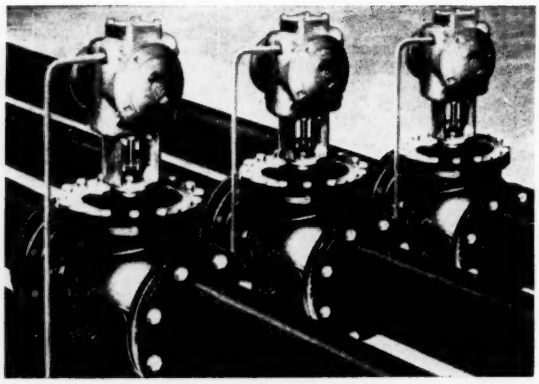

Fig. 12-8. Electro-hydraulic units are widely used for emergency shut-down because of rapid closing.

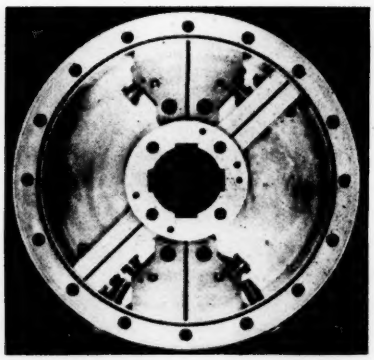

Fig. 12-9. Operation of plug cock is effected with introduction of high-pressure oil in chamber of actuator to move rotor.

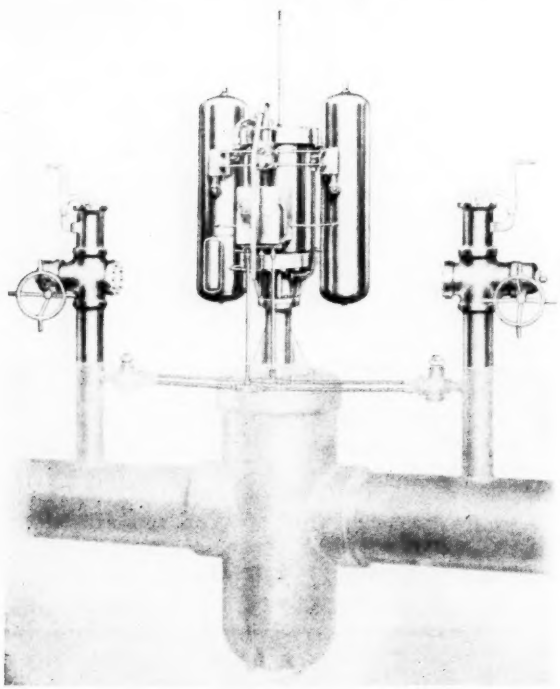

Fig. 12-10. High-pressure gas forces oil into cylinder to operate piston actuation.

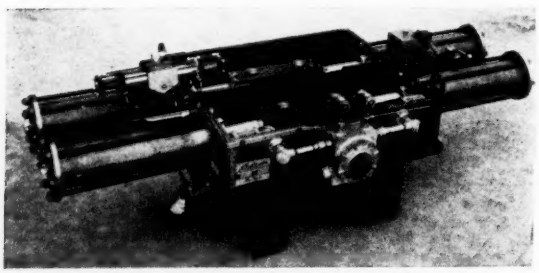

Fig. 12-11. Multiple cylinders are used on large plug valves for pipeline shut-off.

relation to stationary shoes (Fig. 12-9) within a chamber is caused by introducing hydraulic force to opposite quadrants. This hydraulic force is obtained by pressurizing the hydraulic storage tank with high-pressure gas. The center of the rotor assembly engages the stem of the cock to cause rotation of the plug. The rotor closes the exhaust port at the end of the 90-degree stroke to cushion movement.

Use of high-pressure gas to create hydraulic force also can be used to operate a cylinder actuator. A cylinder actuator such as shown in Fig. 12-10 is required for the long travel of gate valves.

Single and multiple pistons also are used for emergency operation of plug cocks. High-pressure plug and ball valves as large as 36" may be operated by a four-cylinder actuator (Fig. 12-11). The unit shown includes automatic shut-down control with a solenoid-positioned four-way three-position valve to pilot stored line gas to the cylinders. One pair of cylinders operates directly on line gas, while the other pair is used for auxiliary operation using an auxiliary manual hydraulic pumping unit, and for controlling speed of the unit. The control unit is designed for a continually-energized electrical system. A time delay with variable time setting is used to preclude operation upon momentary power loss.

Conclusion

It is necessary to know what equipment is available and how it operates before the complete system is set up. Many of the units covered in this section can be adapted to throttling action in addition to the on-off operation required for emergency protection. When the design is such that the complete valve actuator assembly is the slave of a controller, the regulator becomes a control valve with operating characteristics which will create proportional or throttling control. These characteristics, however, may not be acceptable for some emergency applications.

Acknowledgement

Pictures are by courtesy of EIM (Fig. 12-7); Fisher Governor Co. (Figs. 12-1, -2, and -5); General Controls Co. (Fig. 12-6 and -8); Ledeen Mfg. Co. (Fig. 12-11); Rockwell Mfg. Co. (Figs. 12-3 and 4); and Shafer Valve Co. (Figs. 12-9 and 10).

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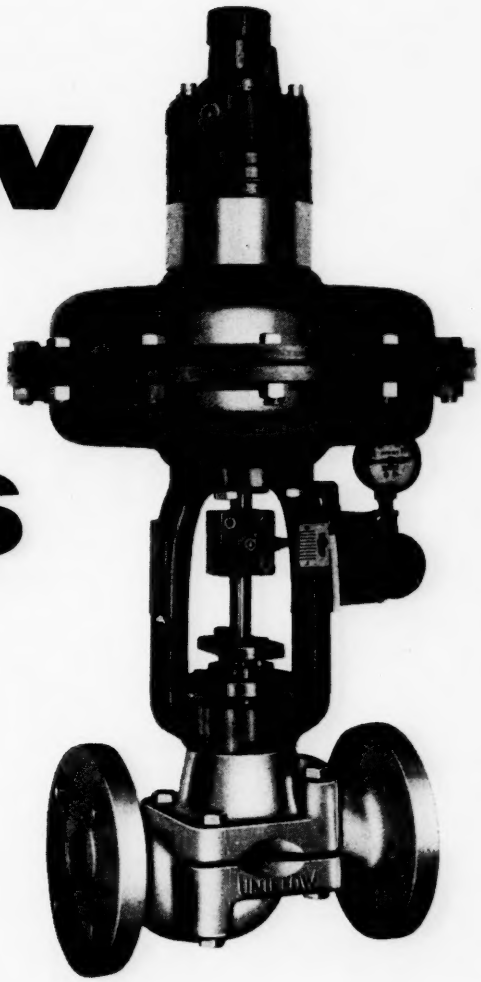

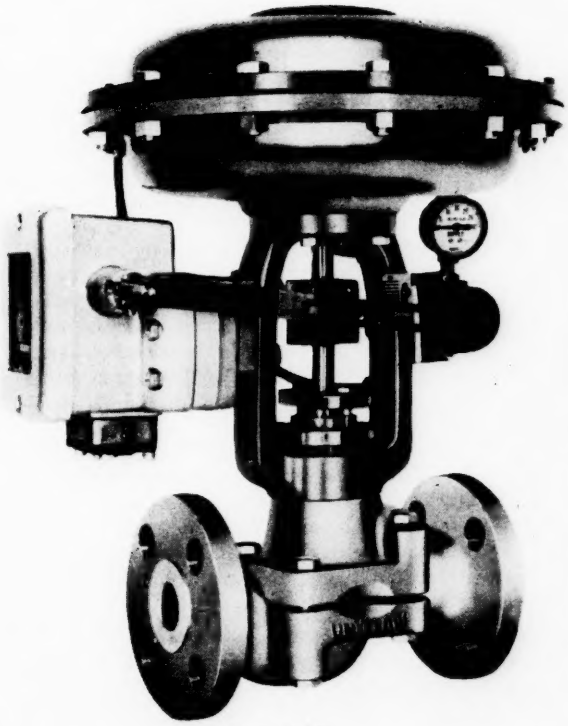

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Orifice Metering

Orifice metering fundamentals include the basic derivation of the head-velocity relationship. The causes for errors are examined, including the effects of deviations in standard structural techniques. Visualization of the physical system can help in proper analysis of metering problems.

HARVEY ELAYER
Richfield Oil Corp.

A METERMAN, or anyone connected with design, installation, or servicing of orifice meters, can solve many baffling metering problems if he is able to visualize what is taking place inside the meter run and orifice.

The record of quantity of gas passing through the meter is not the only information found on the chart. Sometimes information of much greater value, operation-wise, is recorded. Each chart is a faithful record of static and differential pressures at the meter for a 24-hour period. Each chart has a story to tell—if we know how to read it. Very few changes or upsets can occur in a gas-gathering system without being recorded on at least one meter chart. Charts are fine "tattletales."

Primary Elements

There are three generally recognized types of primary elements—the Venturi tube, the flow nozzle and the orifice plate. Several variations of these elements have been used or experimented with at various times. The *Venturi tube* and flow nozzle are of value where low permanent pressure-loss is desirable, or where suspended solids are carried in the fluid being metered. They have little application in gas measurement. They are rather costly to manufacture and are not readily changed after installation. The *thin-plate orifice* is by far the most widely used of these primary elements and, with the special section of pipeline and a differential pressure recorder, forms what we commonly call an *orifice meter.* It is perhaps the most versatile of all fluid meters in industrial use today, and the most accurate.

Presented at the Seventh Annual Instrument Short Course Sponsored by the Southern California Meter Association and the Los Angeles Harbor Junior College, January 30 & 31, 1958.

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FEATURE: Mr. Jack K. Walker, of Consolidated Electrodynamics Corporation, will discuss a Computer Controlled Pilot Plant.

Recorder

The secondary element usually is a recording differential pressure gauge. Most common ranges of these gauges are 50″ and 100″ of water differential pressure. They are usually mechanical in operation—either the mercury "U"-tube-type or the bellows type which is gaining favor. The body of the gauge must withstand full line pressure (up to several thousand pounds in many cases) and yet be able to sense and record differences in pressure between two points of ½% or less of the instrument range. With a 50″ gauge this would be 0.25″ of water, or 1/110 pound pressure. Calibration is usually even closer than this. It is remarkable that instruments of the required sensitivity are yet simple in construction and rugged enough for general field use.

Taps

The recording gauge is connected to pressure taps on the meter run by tubing or small-diameter pipe. There are several possible combinations of pressure-tap locations in relation to the orifice plate; we will only consider two of these. *Line* (*pipe*) taps are located 2½ pipe diameters upstream from the orifice plate and 8 diameters downstream. (By pipe diameter we mean nominal inside diameter of the meter run.) Pipe taps are not used as much now as they

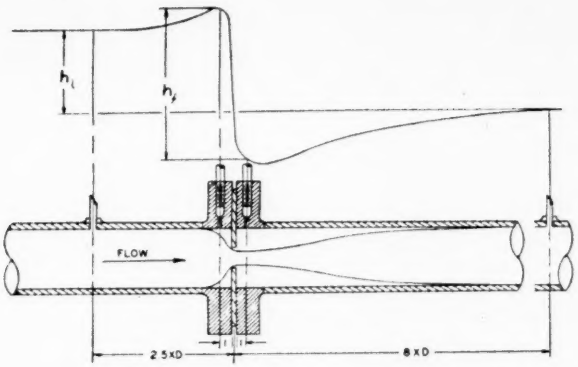

FIG. 1. PROFILE of flow through an orifice and plot of the pressure level along the line. Note: h_l is differential pressure between line taps and h_f is differential pressure between flange-taps.

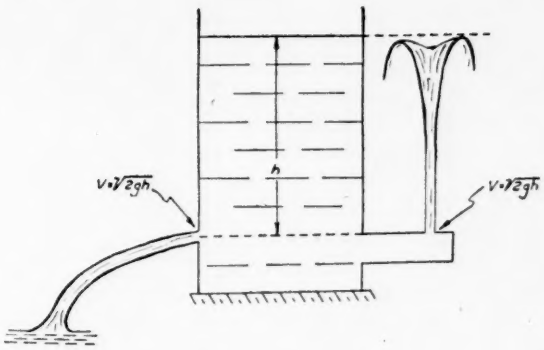

FIG. 2. VELOCITY OF liquid issuing from openings at depth of h is the same as velocity of a free-falling body dropped a distance of h.

were a number of years ago: their basic advantage is simple installation. Standard companion flanges hold the orifice plate, and pipe couplings are welded to the line over holes drilled for the pressure taps. This sometimes can be done using existing flanges in the line.

Flange taps are located 1" on each side of the orifice plate, regardless of meter-run line size. This type of connection is almost standard now for many reasons:

1. A shorter meter run can be used than with line taps.
2. A neater, close-coupled piping job for the recording gauge is possible.
3. A greater tolerance on the inside diameter of the meter run is permissible than with line taps.
4. The differential pressure is much greater with flange connections than with line connections for the same flow and and orifice size.
5. For equal recorded differentials, the permanent pressure loss is less with flange-connected than with pipe-connected meters.
6. The expansion factor F_{e2} varies less for flange-connected meters than for pipe-connected meters.

For metering non-compressible liquids the differential pressure is the only record required on the chart. For compressible gases or vapors, a record of static pressure in the line is required, and normally this is measured at the same point that is used for the downstream differential connection.

Pressure Head

The approximate flow pattern of the fluid as it increases in velocity in passing through the orifice and then slows down as it expands to full line size again is shown in Fig. 1. The velocity through the restriction must be greater than the velocity through the larger area. If pressure is measured at various points along the length of the meter run, a curve similar to that shown at the top of Fig. 1 results. The location of flange and line tap connections is indicated, also their relation to the pressure curve. Note that a differential-pressure recorder connected to the flange taps would indicate a difference in pressure (h_f) very near the maximum attainable for any pair of points on the curve. Line taps would indicate the minimum difference in pressure (h_l), which is the permanent pressure loss through the orifice.

This pressure curve is the starting point for developing the general flow formula and various factors that go into computing the coefficient relating pressure differential and flow.

Head and Flow Relationship

In the year 1590 Galileo is said to have conducted tests by dropping various kinds of objects from different levels of the leaning tower of Pisa, and to have timed their fall and measured their velocities. He was the first to express the velocity of a falling body in a mathematical form. He found the velocity (V) which a free falling body will attain in falling through a vertical distance (h), neglecting air friction, is $\sqrt{2gh}$ where g is the acceleration due to gravity. The actual value of g varies slightly at different latitudes on the earth's surface—from a minimum of 32.09 ft/sec/sec at the equator to 32.26 at the poles. The average value is 32.17 ft/sec/sec.

The instantaneous velocity of a free-falling object can be calculated when we know the distance it has fallen by the formula $V = \sqrt{2gh}$. Just how this applies to flow measurements is shown in Fig. 2.

When a liquid, such as water, flows through an opening in the side of a tank, the jet has a velocity $V = \sqrt{2gh}$, where h is the liquid head in feet between the water level and the opening. If issuing vertically, the jet will rise very nearly to the height h above the opening (air friction, as well as friction at the opening tend to reduce this height). The velocity of the jet is the same as that which a free-falling object would acquire in falling through a distance equal to that from the level of the upper surface to that of the opening. This principle was discovered by Torricelli in 1644 and is known as Torricelli's theorem.

Specific Gravity

Note that density (specific gravity) of the liquid does not enter into the equation for calculating *veloc-*

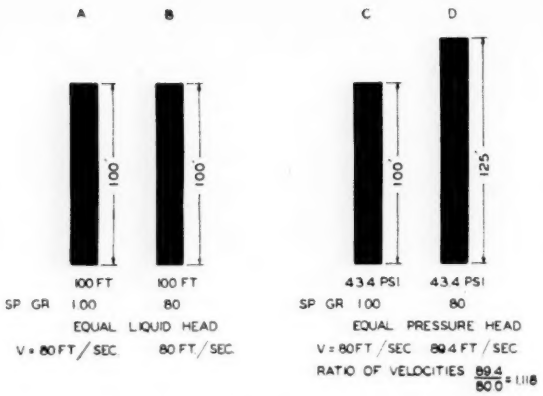

FIG. 3. EQUAL HEAD (height) produces equal velocities—but, when head is deduced from pressure sensing, correction must be made for specific gravity in order to predict velocity.

ity of the jet. The specific-gravity factor, however, is of importance when pressures are used as a basis of measurement. Usually it is not practical to measure the head h directly. We can, however, measure the *pressure* at the level of the orifice, and convert this pressure reading to fluid *head* by use of the proper density or specific-gravity factor.

This correction factor is illustrated in Fig. 3 for water and oil. Note that the ratio of the velocities at equal pressure is 89.4/80=1.118. Fig. 3 shows the relationships between head, pressure, and velocity.

The orifice-meter specific-gravity factor, therefore, is actually the ratio of velocity of the flowing medium compared to the velocity of a standard medium, when each is acted on by the same pressure head. The standard medium for liquid measurement is water, and for gas measurement is air.

Now being able to calculate the velocity of the jet in Fig. 2, it would be a simple matter to multiply by the area of the opening to arrive at a volume rate of flow. We now have a crude form of orifice meter. All we have to do is adapt it for use in a closed pipeline system. This is simplified by (1) the available tables and standardized procedures to compute coefficients, (2) specifications and allowable tolerances for construction and installation of orifice meter runs, and (3) the modern recording differential pressure gauge. Actually there has been an enormous amount of work involved in bringing orifice meter measurement up to its present standard of high accuracy and dependability.

Referring to Fig. 1, let's assume we have fluid flowing through the upstream section of the meter run at a certain average velocity. When it arrives at the orifice plate it must suddenly increase in velocity for all to pass through the orifice. The velocity through the orifice is inversely proportional to the areas of the meter tube and the orifice. Actually the point of highest velocity is a short distance downstream from the orifice, where the jet assumes its smallest diameter. This is called the *vena contracta*.

According to Bernoulli's theorem the energy in a flowing fluid is made up of the energy resulting from the *pressure* of the fluid as well as the energy associated with the *velocity* of the flow. The total energy is the sum of these two factors. Therefore, if the velocity of flow in a pipeline increases, the static pressure must decrease. This change in pressure is the differential pressure that is recorded on the gauge and is directly related to pressure head of fluid. By converting to fluid head, a theoretical velocity of flow through the orifice can be calculated by using the formula $V = \sqrt{2gh}$.

Discharge Coefficient

Due to friction and other factors, the actual flow is considerably less than theoretical. The ratio of the *actual* to *theoretical* flow gives a factor which we call the discharge coefficient, or "K" value. This value has been determined experimentally. It varies with different orifice-to-pipe diameter ratios and with different types of connections. Generally the value lies between 0.60 and 0.70. By combining this experimental value with the theoretical formula, and including time and dimensional values, we arrive at a practical method of computing flow through an orifice meter. The new formula is $Q = C\sqrt{h}$ where Q is quanity, h is differential pressure in inches of water, and C is a coefficient computed for the particular installation and flowing conditions. It is numerically equal to the rate of flow with 1" water differential pressure across the orifice.

Gas Factors

With gas measurement additional factors must be considered. Gas is compressible and at low pressure follows Boyles' law closely (that is, volume varies inversely with pressure).

It is seldom that pressures are constant enough to apply a pressure correction to the coefficient. Therefore a continuous record of line (static) pressure is required on the chart. This is usually a blue line, recorded along with the red differential line. The formula for computing gas flow now becomes $Q = C\sqrt{hP}$ where P is pressure in psia.

Gas under high pressure is found to deviate from Boyles' law and actually occupies a smaller volume than the pressure ratios indicate. The deviation factor (F_{pv}) varies with gas gravity, pressure and temperature. As this factor remains fairly constant over normal variations in pressure on the meter, the factor is included in the coefficient.

Specific gravity and temperature corrections also play an important part in gas measurement. These factors also are included in the coefficient.

Construction Standards

A great deal of experimental and correlation work has been done by committees representing various groups or associations vitally interested in gas measurement. Detailed construction and installation specifications are published for orifice plates, meter tubes, length of pipe preceding and following an orifice, straightening vanes, use of orifice fittings, pressure tap holes, and thermometer wells. These specifications

have been set up with the idea in mind that all construction could be carried out in an average machine shop without special equipment. They also agree with the meter installations used to establish the orifice discharge coefficients. All construction details and tolerances listed are intended to assure that no deviations in construction are made that would change the base coefficient as established by experimental work.

Fig. 4 shows the effect on the flow pattern of different line size even though the orifice is the same in both cases. In the small line (left) there is less change in velocity as the gas passes through the orifice, resulting in less contraction of the jet. Coefficient tables bear this out. Take, as an example, coefficients for 2" standard and schedule-80 pipe with a 1.375" orifice. The standard-weight pipe coefficient is 433.50; the schedule 80 is 448.57. This is a difference of 3.5%, although the difference in pipe diameter is only approximately $\frac{1}{8}$". It doesn't necessarily have to be the wrong size pipe or wrong coefficient for the type of meter run installed. Such a deviation can be caused by scale or wax deposits on the inside bore of the meter tube.

Fig. 5 shows a normal flow pattern where the average velocity of the gas stream is approximately 82% of the maximum velocity at the center of flow. With rough pipe, the flow near the wall of the pipe is slowed down; therefore the flow in the middle must increase in velocity. The effect of this is similar to having a smaller size meter tube. There will be less change in velocity as the gas stream passes through the orifice; therefore, the reading will be low.

This condition could occur where the inside bore of the meter tube has corroded. Wax, oil emulsion, or dirt deposits also can cause an error such as this. For corrosive conditions the inside of the meter tube can be plastic coated. This also leaves a very smooth surface which has less tendency to hold foreign deposits on its surface. There is some question about the effect of the smooth surface on the base coefficient, but that is probably the lesser of two evils.

Fig. 5 also shows the effect of installing the orifice too close to a bend in the line. The center of highest velocity is displaced to one side of the line and, entering the orifice at an angle, causes distortion of the flow pattern through the orifice. Results could be high or low. Additional length of straight pipe is probably the best remedy. When two bends not in same plane are involved, straightening vanes should be installed to eliminate swirling of the gas stream.

Fig. 6 shows the effect of a rounded edge on the orifice or a bevel upstream; this always results in a low reading. The flow of gas from the side into the orifice is not required to make such an abrupt change in direction as it would if the orifice had a sharp edge. This results in less than normal contraction of the jet.

Hydrate Formation

A condition often encountered with high-pressure wet-gas measurement during the colder months of the year is hydrate formation. This forms as a slushy snow-like material that seems to travel along with the

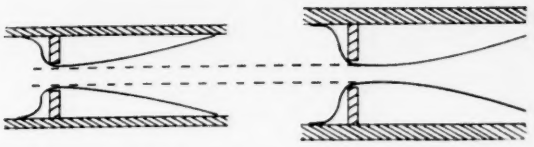

FIG. 4. IDENTICAL orifices produce different heads when pipe diameter varies.

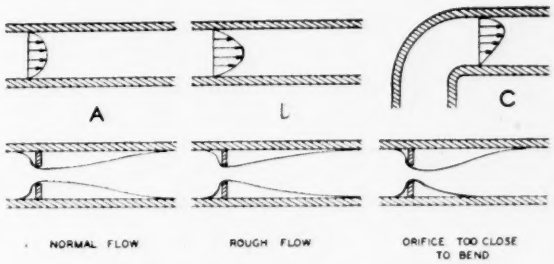

FIG. 5. CALIBRATION TABLES assume a normal velocity profile across the pipe upstream of the orifice, as at A. Rough walls (B) or bend in pipe (C) destroys this assumption.

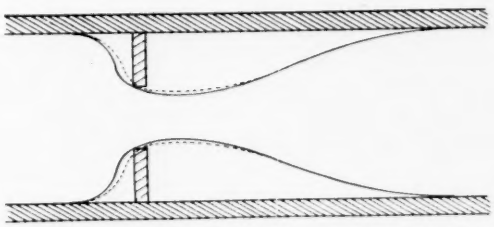

FIG. 6. ROUNDED ORIFICE yields low readings because edge does not produce expected convergence of flow.

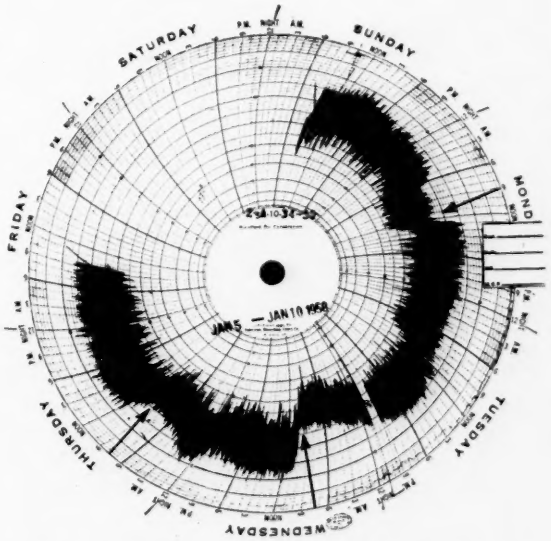

FIG. 7. ARROWS SHOW depressed readings due to hydrate formation during cold nights, owing to equivalent rounding of edge of orifice plate by hydrate condensation.

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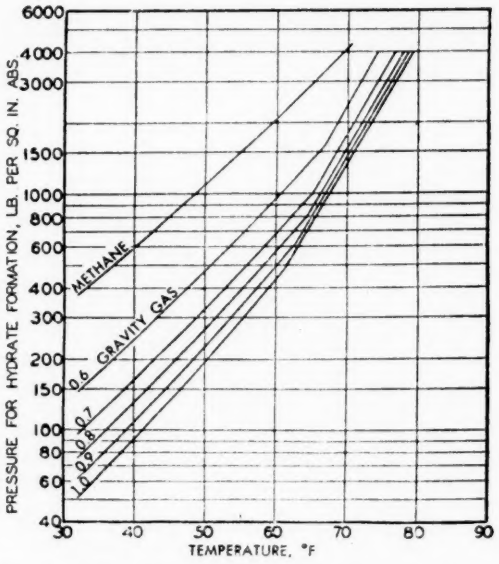

FIG. 8. PRESSURE-TEMPERATURE picture shows conditions where hydrate formation can be expected for various gases.

gas in flake form until it hits an obstruction in the line, such as an orifice plate. It piles up on the plate around the orifice like a doughnut. The effect is the same as a bevel or rounded edge on the orifice, and the differential reading will be lowered. Continued build-up, however, will tend to plug the orifice and cause a high reading. Accumulation of dirt, oil or heavy emulsion on the orifice plate will have the same effect.

Fig. 7 shows a chart revealing hydrate formation on the orifice plate. Note how the reading returns to normal about 10 or 11 in the morning when the weather warms up. Fig. 8 is a set of curves for estimating hydrate formation temperatures.

Maintaining the gas line and recording gauge above the hydrate formation temperature is the best remedy, but not always practical. A small amount of anti-freeze solution poured in on top of the mercury-type meters will often prevent the gauge from freezing.

Gauge Connections

Piping up the recording gauge is critical because we are measuring minute differences in pressure. For wet-gas measurement it is important that the lines slope continuously back to the orifice fitting, and it is often advisable to install the fitting at an angle to maintain this slope all the way to the pressure taps.

Gate valves or full-opening valves of some type should be used whenever possible at the pressure taps. It takes only a few drops of water in a trap in the line to give a false differential reading, and often this is difficult to detect from the chart record. Piping on the recording gauge itself should be kept as simple as possible and yet convenient to make all necessary checks of the gauge. There should, of course, be no leaks in the piping.

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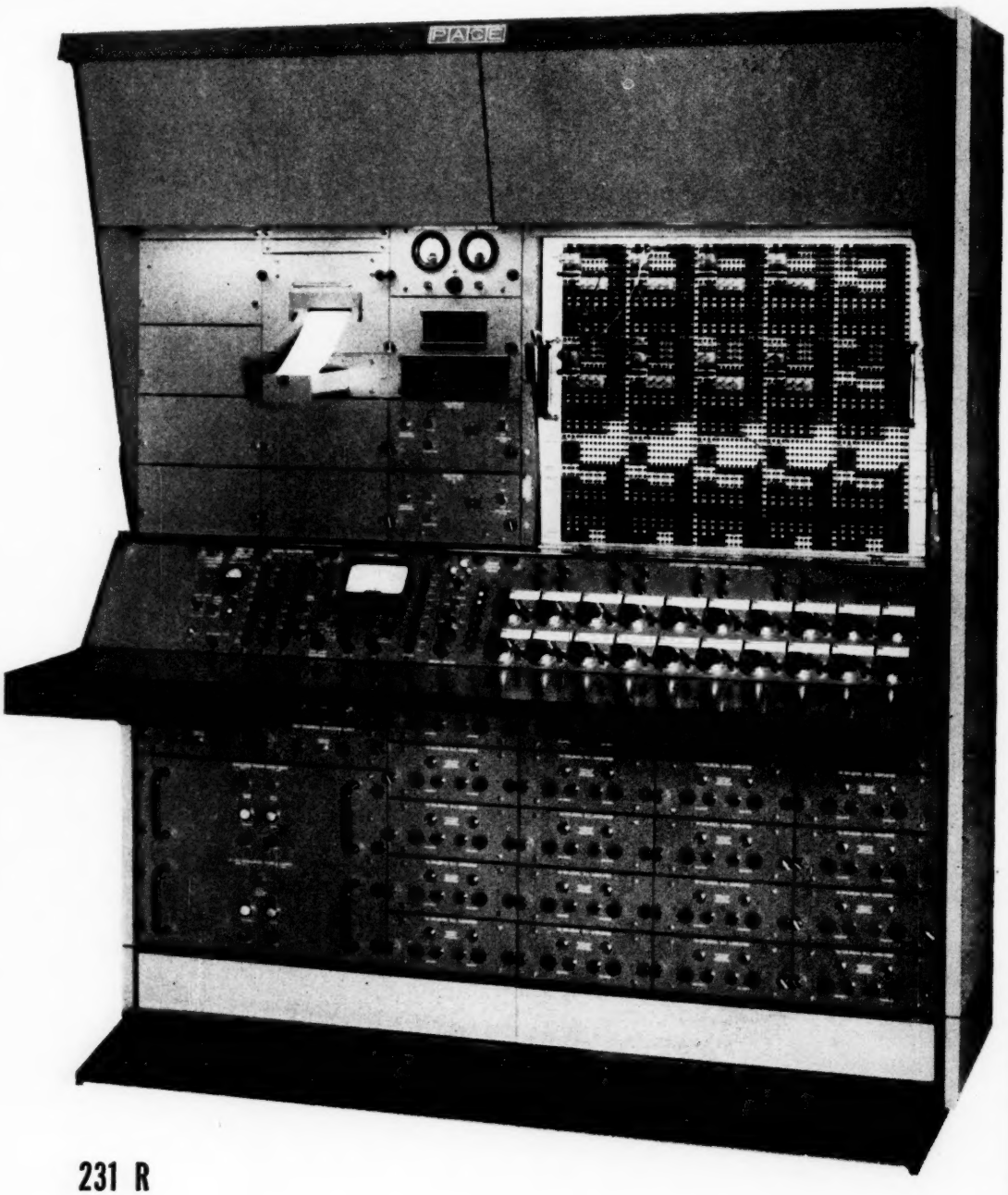

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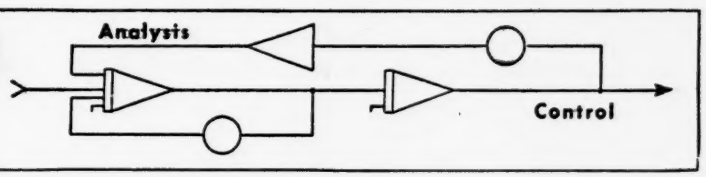

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DDA Council

Stan Rogers, Convair, San Diego, Calif.; Chairman, Board of Directors

Bits

This month we cover two Eastern Simulation Council meetings, at Avco in Lawrence, Mass., and at Republic Aviation in Mineola, Long Island, both meetings reported by Bob Yeager; and a Central Simulation Council get-together at the University of Wichita and Boeing in Wichita, Kansas, reported by Ted Williams.

The talks covered are:

"The Avco TAVET (Temperature Acceleration Vibration Environmental Tester)" by Charles Cohen;

"Computer Problems in Aircraft and Missile Simulation" by George Mayer and Richard Kopp;

"The Simulation of Non-Linear Phenomena" Dr. A. T. Murphy, chairman.

"Circuits for Friction Simulation" by George Castile;

"Conducting Sheet Simulation of Field Problems" by Robert Schrag;

"Digital Simulation of an Air War" by Donald Wendland;

"Simulation of Non-Linear Servomechanisms" by Warren Murray.

Pieces

EASTERN SIMULATION COUNCIL MEETING OF FEBRUARY, 1958 AT AVCO

Bob Yeager (Electronic Associates, Long Branch, N. J.), Secretary of the Eastern Simulation Council, reports that their February meeting at Avco Manufacturing Company's Advanced Research and Development Division in Lawrence, Mass. was almost snowed out.* Talks were scheduled by Henry Bowes (Electric Boat) on the Universal Submarine Simulator and Frank Davidson (Avco) on the Avco Dynamic Pressure Simulator. We don't know if it was because of the weather or not, but only Charles Cohen's talk on the Avco TAVET was reported, so it's the only one described here.

* * *

Cohen on TAVET

TAVET is derived from Temperature, Acceleration, Vibration, Environmental Tester, and is a centrifuge encased in a temperature chamber and mounted on a vibration unit.

The need for highly reliable components for unmanned vehicles has increased the importance of efforts to simulate the true flight environment in laboratory testing. In particular, the ICBM experiences high levels of heat, sustained acceleration, and vibrations, all of which act *together* to induce failures during powered climb and again during re-entry.

To determine the feasibility of combined environmental testing Avco developed a test facility in which the component is subjected simultaneously to high or low temperatures, sustained acceleration, and vibration. To get the use of the facility as quickly as possible, readily available commercial equipment was specified. The following performance specifications represented a compromise between the anticipated missile environment and performance limitations of the equipment:

Specimen weight	25 lbs.
Specimen size	18″ cube
Sustained acceleration:	Variable from 1 to 75 g's
Vibration frequency	20 to 500 cps
Vibration level	10 g max.
Temperature	−65°F +250°F

The basic units selected were Genisco's C-159 centrifuge and an

*Wonder how it compared with some of the snow jobs your Editor has gotten elsewhere?

MB 25h vibration exciter system. The centrifuge has a capacity for a 100-lb specimen and an infinitely variable range of 1 to 75 g with a limiting centrifugal capacity of 2000 g-lb at 280 rpm. The vibration exciter is a 3500-lbs force generator with a frequency range of 2 to 2000 cps. The initial design approach was to enclose the test specimen in a small temperature chamber mounted on the centrifuge arm, but the required size of the chamber precluded use of the Genisco centrifuge. By insulating and temperature-controlling the entire centrifuge enclosure, however, it was found that a good balance could be maintained between specimen size and weight of vibrating components. The centrifuge was then modified to provide vibrating acceleration at right angles to the plane of the radial vector, by replacing the Genisco arm with one made of magnesium thin wall casting. The Genisco framework was mounted above the MB exciter and fastened to the exciter body in such a way that its vertical shaft axis was concentric with and perpendicular to the top of the exciter shake table. The arm and shake table were connected by means of a push rod extending up through the centrifuge shaft to the arm hub.

Heat exchangers supplied with brine were attached to the outside of the centrifuge tub, which was insulated and provided with a vapor barrier. The brine is trichloroethelene because of its inherent stability for the temperature range of −65° to +250°F. The brine is cooled by a cascaded Freon 13-Freon 22 refrigeration system, and there is a chemical dryer for low-dew-point air. Air supplied to the chemical dryer furnishes about 15 cubic feet per minute of −65°F dew-point air for purging the test space and maintaining a positive pressure so that all air leakage will be to the outside.

Preliminary tests indicate that vibratory accelerations of 10 g's for a specimen weight of 20 pounds can be obtained from 30 to 400 cps. Vibration at higher frequencies is possible, but only at levels below 10 g. The use of compensating networks to flatten the response is being studied, and the adaptability of the machine to the use of random as well as sinusoidal inputs is under consideration.

* * *

EASTERN S/C MEETING OF 21 APRIL AT REPUBLIC AVIATION

Bob Yeager also reported on the 21 April meeting of the Eastern Simulation Council, which was held at Republic Aviation Corporation, Mineola, Long Island. At this meeting the following speakers were scheduled:

Kenneth Kuhn (Republic)—"Six Degree-of-Freedom Simulation"

Frank Fitzgerald (Republic)—"Function Generation—Functions of Two Variables"

George F. Mayer and/or Richard E. Kopp (Grumman Aircraft)—"Computer Problems in Aircraft and Missile Simulation"

Naoji Morishita (American Bosch Arma)—"Analog Simulations of Digital Computer Operations"

Howard Price (Avco)—"Programming of Large Dynamic-Range Problems"

Julius Port (Republic)—"Simulation of Eigenvalue Problems on an Analog Computer"

However, only the Kopp-Mayer talk will be condensed here because the generation of functions of two variables as well as the solution of nuclear problems (the source of the Eigenvalue Problems) have been covered previously.

* * *

KOPP ON AIRCRAFT AND MISSILE SIMULATION

Mr. Kopp introduced his subject by remarking that very little information is available concerning the actual techniques of aircraft and missile simulation and expressed the hope that his presentation would inspire others to write of their experiences.

The analog computer facility at Grumman Aircraft has grown from a 40-amplifier, 4-servo installation in 1949 to an installation now consisting of 250 amplifiers, 32 servos and considerable nonlinear equipment. Problems also have grown, usually somewhat faster than the computer installation. This resulted in the need for specialized equipment, which was designed to make use of available parts.

Early simulations at Grumman were linearized about some trim point, and offered few difficulties. But in 1954 a simulation of the F11F-1, which covered dynamic stability, trim change with speed, speed stability, pitch-up characteristics,

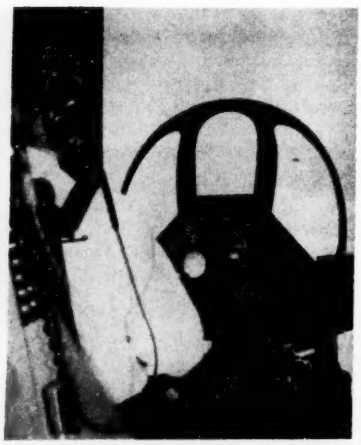

FIG. 1. TARGET appears on screen in front of simulator.

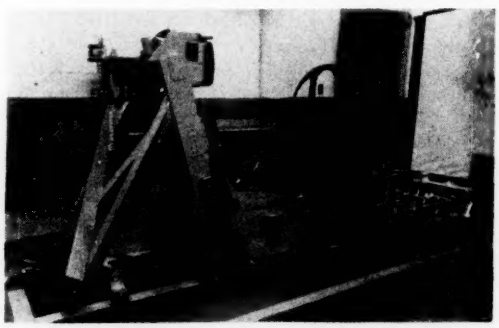

FIG. 2. SIMULATOR

control sensitivity, and inertia coupling in roll changed all this.

One of the first problems encountered was incorporation of the human pilot in the control loop. Two real-time fight simulators were designed which included much of the actual aircraft longitudinal control hardware. Information was presented to the pilot in the form of a visual display, instruments, and force feedback applied to the stick. Figs. 1 and 2 show one of the simulators.

The program was divided into two stages. First was the study of longitudinal stability, trim change, pitch-up characteristics, and control sensitivity. A three-degree of freedom (pitch, longitudinal motion, vertical motion) simulator was constructed. Aerodynamic derivatives were a function of Mach number only. The generation of these nonlinear functions and multiplication by other variables in the problem were performed using a modified Reeves input-output table. Six functions were generated on one table by dividing the roll into two portions and again dividing the plotting area into three segments. Small, 2½" wire-wound, resistor cards were used to pick off the function.

Buffet boundary was generated by comparing lift coefficient with a function of angle of attack. Linear corrections were then made to the lift and moment coefficients, and a buffet signal was applied to the force stick servo.

The pilot wore a g-suit to simulate normal "g" acceleration; a voltage proportional to normal g's actuated a servo system which controlled the pressure in the g suit. Another attempt to provide g force was the use of shoulder straps on the pilot which pulled him into the seat with a force proportional to g's. Pre-loading the straps gave a feeling of negative g's when the pre-loaded force was decreased.

The instrument panel shown in Fig. 3 consisted of modified standard aircraft meters. These were an altimeter, a combination Mach-knots meter, rate of climb meter, accelerometer, speed brake indicator, rpm meter, and an elevator indicator.

The visual display presented to the pilot was generated by an optical projection system. A colored slide taken of the horizon was projected onto a translucent screen using a servo-positioned mirror.

The second stage of the study was a roll investigation for which a five-degree-of-freedom simulator was needed, with roll, pitch, yaw, vertical, and lateral motions. The major problem encountered here was the generation and multiplication of twelve functions of angle of attack,* because frequencies of two cycles per second with reasonable amplitudes could be expected. This prohibited use of the input-output tables, so a hydraulic function generator was made using a hydraulic servo with non-linear cams driving linear Bourns potentiometers.

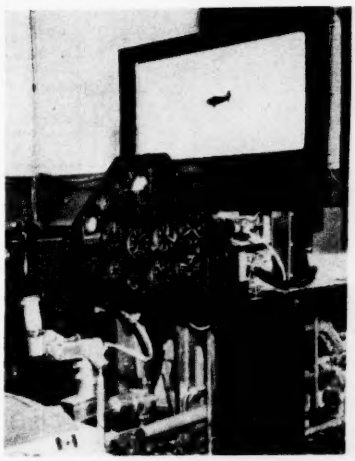

FIG. 3. INSTRUMENT panel uses modified standard aircraft instruments.

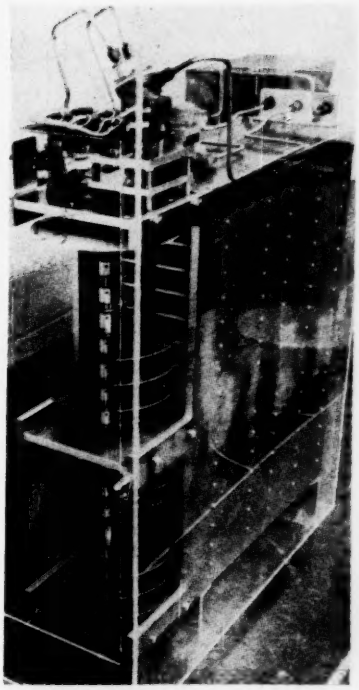

FIG. 4. FUNCTION generator.

The instrumentation was the same as for the three-degree-of-freedom simulator except that the Mach-knots meter and angle of attack meter were not used, and a combination sideslip, rudder deflection meter, a combination angle-of-attack, stabilizer deflection meter, a roll rate meter, an attitude gyro indicator, and a compass were added. The same type of visual display was used, but roll was added by mounting the colored slide in the center of a gear which was controlled by a servo system driven by roll rate, and yawing motions were added by mounting the projector and mirror on a Reeves roll table.

A target tracking attachment was added to the three-degree-of-freedom simulator to determine the effectiveness of the F11F-1 fighter as a gun platform. The target (See Fig. 1) consisted of a front-view silhouette of a fighter scaled down to appear to be at a distance of one mile. This was attached to a wire and raised or lowered in front of the visual display by a servo positioned from a twice-integrated random noise signal representing the expected accelerations. Summed along with this target position voltage were voltages representing pitch and attitude of the simulator. A gun sight reticle was projected from the rear of the screen using another mirror servo. The object was to keep the target in the gun sight reticle. To evaluate the F11F-1 as a gun platform the RMS values of the error were recorded for different pilots.

Next a research simulator was designed to evaluate STOL (short take-off and landing) aircraft, using the same five-degree-of-freedom simulator as a base. The visual display consisted of a scaled-down side view of an airplane silhouette capable of moving vertically and pitching about its CG. This was accomplished by attaching the silhouette to two wire pulley systems, one at the nose and one at the tail. A continuous belt painted with a landscape and driven by a velocity servo was used to give the illusion of forward motion.

Presenting the pilot with the necessary flight instruments was a problem of major concern. Originally galvanometer-type meter movements were used. This type of display seemed satisfactory to the analyst and engineers with no actual flight experience. However, serious objections were raised when experienced

*For his control system of the Ryan Vertijet at U. S. Naval Air Missile Test Center (Pt. Mugu, Calif.), George Smith (Ryan) hooked 20 of the small Reeves cylindrical cams in tandem and positioned them with a Reeves roll table.—Ed.

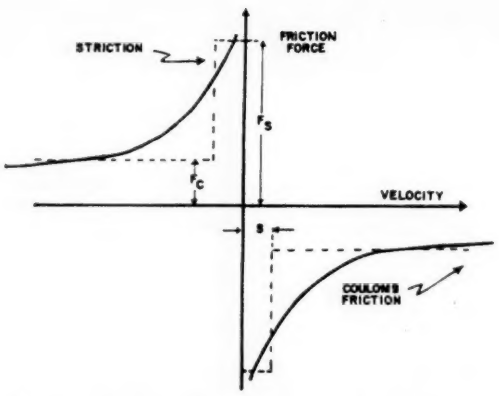

FIG. 5. DRY FRICTION is a combination of coulomb friction and striction.

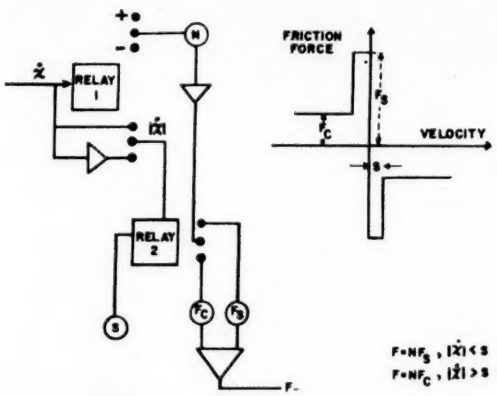

FIG. 6. CIRCUIT for simulating friction.

test pilots were asked to evaluate the simulator's performance. Even though the necessary information was being presented to the pilot, the unrealistic instruments distracted the pilot so much that they impeded his efforts to truly evaluate the flight condition. It was therefore decided to modify standard flight instruments by removing the actuating mechanisms and replacing them with synchro receivers. Synchro transmitters geared to servos could thus drive multi-turn dial instruments directly from the analog computer.

Mr. Kopp then gave details concerning the instrument system and the function generator used to generate and multiply six functions of angle attack. The latter is shown in Fig. 4. Details and performance figures for the visual display, for stick feel, and some other factors included to add realism were also given.

The problem of parameter scaling and time scaling when trajectory studies are being made was also discussed. The main drawback to the separation of the problem into a number of phases, as is often done, is that the initial conditions of one phase usually depend on the final conditions of another. A solution investigated at Grumman was to program the two parts of a homing phase using a different time scale for each part. The initial conditions for the second part were automatically computed from the first and a technique was developed to apply them automatically. The two phases were programmed on different computers with a 10-to-1 difference in time scale. While the first subphase was in operate the second was kept in reset.

A method of varying the time-scale continuously was analyzed in an attempt to overcome velocity limiting of servos at the end of the homing phase and to extend the solution time where parameters were changing rapidly. Since the amplitude of the variables does not change with a time-scale change, there is no reason why the time scale could not be changed in the middle of the solution. If this premise is accepted, there is likewise no reason why the time scale could not be changed 10 or even 100 times during the solution; the limiting case would be a continuously varying time scale. To accomplish this, every integrator in the problem would need a pot preceding it. A servo having the necessary number of multiplying pots and driven by integrating a constant was used to produce the desired continuously-changing time scale.

Mr. Kopp explained the mathematical justification for his varying time scale and concluded his informative presentation by describing Grumman's plans for a multi-purpose research flight simulator and combined analog-digital simulation.

CENTRAL SIMULATION COUNCIL MEETING OF 5 MAY ON NON-LINEAR PHENOMENA

Thirty-six members of the Central Simulation Council met at the University of Wichita in Wichita, Kansas for their eighth meeting, held on 5 May 1958. Dr. A. T. Murphy of the University's Electrical Engineering Department served as chairman of the technical session, which followed a delicious lunch in the Pine Room of the Commons Building. Theme of the session was "The Simulation of Non-Linear Phenomena".

Castile on Friction

George E. Castile (Engineer, Computers, Beech Aircraft Corp., Wichita, Kansas) spoke on "Circuits for Friction Simulation", giving examples of the occurrence of dry friction and of the circuits suitable for its simulation. George showed that dry friction could be approximated as a combination of "coulomb friction" and of "striction" (Fig. 5). Striction is the high force required initially to move an object which is subject to dry friction over and above inertia effects, and coulomb friction is the force required to sustain motion. He showed that striction can vary depending on the direction of motion of the object and on the frequency to which it is subjected. He considers the circuit shown in Fig. 6 as the most desirable.

Schrag on Field Problems

Dr. Robert L. Schrag (Associate Professor, Department of Electrical Engineering, University of Wichita) presented his paper, "Conducting Sheet Simulation of Field Problems" next on the program.

Bob described how field problems with mathematics too complicated for ready solution by standard computational means can be solved by experimental means using homogeneous and heterogeneous mildly conducting media. The possibilities of simulating a cylindrically symmetrical electrode by means of a conducting sheet formed the basis of his talk. He reviewed the mathematics of the usual field problem in cylindrically symmetrical cases as expressed

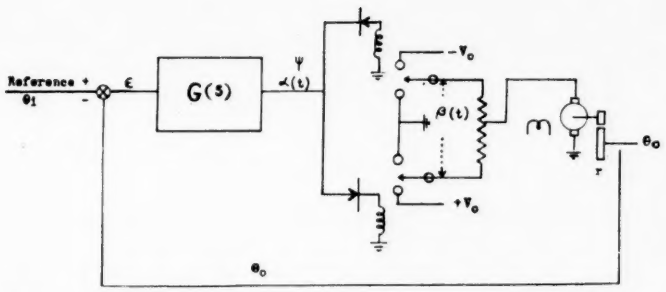

FIG. 7. **NON-LINEAR** contactor servomechanism with dead zone.

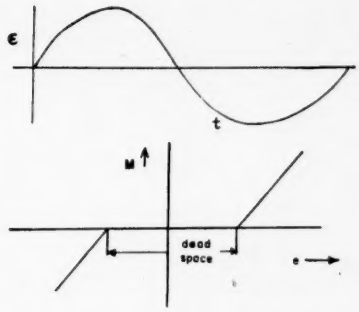

FIG. 8. INPUT SIGNAL.

by LaPlace's equation for the non-space-charge case and by Poisson's equation for the cases involving space charges. He discussed several methods of expressing the analog of space charge on the conducting sheet, including the use of holes punched into a conducting sheet to reduce its conductivity and also the use of light-sensitive paper to form a source of charges. Bob also told about the use of an electrolytic tank with varying conductivity.

Art Murphy asked if it were possible to mechanize the readout of lines of constant field strength by the use of a probe equipped with feedback mechanism. Bob replied that this was certainly possible, but would require a very complicated mechanism. He went on to say that an even more difficult problem was drawing the electron rays in such fields, and this he did not know how to mechanize.

Jerome Kennedy (Electronic Associates, Inc., Mt. Prospect, Illinois) described the work of a professor at the University of Michigan* who uses a system of distributed current sources in a conducting sheet to achieve a known variable space-charge effect. This permits the rapid change of problems since there is no necessity for a change in the physical configuration of the test tank. Only rheostats attached to each one of the matrix of electrodes in the sheet need be changed to achieve a completely different space-charge simulation.

Wendland on Air War Simulation

The third paper, entitled "Digital Simulation of an Air War", was presented by Donald E. Wendland (Supervisor, Operations Analysis for the Preliminary Design Department, Boeing, Wichita, Kansas). Donald's paper was a fascinating discussion of the use of an IBM 701 to simulate by operations-research techniques the problems faced by the offense and defense in a bombardment raid during a modern air war. The simulation procedure contains factors to handle the phases of Friendly Environment, Peripheral Defense, Area Defense, and Local Defense in the attack. It includes warning and guidance radar, surface-to-air missiles, and fighters for the defense; while it considers air-to-surface missiles, gravity bombs, and electronic countermeasures for the offense. Its main use is in testing various concepts of attack and defense strategy as a function of the capabilities of various possible bomber designs. The effects of raid timing and bomber strength as strategy factors were vividly illustrated by Don in his talk.

Don described the mechanism of his so-called "bookkeeping method" of keeping track of the status and remaining capabilities of both attack and defense on the computer as the air battle proceeded. The possible variability of the air battle is handled by allowing a Monte Carlo procedure of random numbers to specify some of the possible attack and defense procedures.

The model allowed the offense to be varied in light of a specific defense strategy. However, no provision was made for the corresponding variation of the defense strategy.

An especially valuable item in the program is the "events tape" which records each event of the campaign and maintains a running score of the campaign as it proceeds. This is equivalent to the commander of our Strategic Air Command's having a blow-by-blow account of the air war as it proceeds.

The talk evoked great interest in the audience and resulted in a large number of questions at the end. Some of these follow:

R. W. Hippe (IBM) asked whether the monetary value of the bombers, targets, and so forth were included in the model for cost analysis purposes. Don replied no; he'd like to do this but hasn't yet.

David Hohlfeld (Beech Aircraft, Wichita, Kan.) asked if factors of bad weather and faulty navigation were taken into account. Don answered yes, as a statistical factor supplied by the Air Force.

Asked by A. J. Craig (University of Wichita) if the model gave any surprising results, Don said yes, several, and described how the improper spacing of bomber waves could result in the first wave's getting through to the target and causing a huge amount of damage while succeeding waves sustained very large losses.

Bob Beck (Digital Computer Laboratory, Boeing, Wichita, Kansas) explained that each set of campaign conditions requires about 15 minutes of computer time to calculate and print out, and that the limit of the campaign size is the storage of the computer.

Don offered to discuss details of the program with any interested individuals.

* * *

Murray on Non-Linear Servomechanisms

The last paper on the program was presented by Warren A. Murray (Engineer, Flight Test, Boeing Aircraft, Wichita, Kansas) and entitled "Simulation of Non-Linear Servomechanisms." It discussed work he is doing for his master's thesis at the University of Kansas and describes the analysis of a non-linear contactor servomechanism with dead

*Wasn't that Vern Larrowe?—Ed.

zone (Fig. 7). The servo he is analyzing combines a linear transfer function with another non-linear one. It was analyzed by the method of "characteristic loci." The input used was a pure sine wave clipped by the dead zone, with only the fundamental of the clipped wave (i.e., with center missing, Fig. 8) transmitted to the non-linear mechanism. This permitted him to express the Fourier Transform of the input to the non-linear element.

Warren plotted a family of phase-plane diagrams of the non-linear portion of the servomechanism as a function of amplitude and frequency. He also plotted a phase-plane diagram of the linear portion of the servo as a function of frequency alone. He was thus able to find intersections of the linear curve with the proper non-linear curve by noting that the frequency at the intersection had to be the same for both curves. Thus the amplitude of the output as a function of the input amplitude could be found for various frequencies of oscillation.

He was able to obtain the foregoing results both from theoretical calculations and by simulating the servomechanism on an analog computer.

Warren also showed the application of his method of analysis to the case of control of liquid level on a tank fitted with a float showing dead space.

Following the technical session, a tour was conducted through the analog computer facilities at Beech Aircraft Corporation. The Beech facility (under the direction of Jim Pierce) consists of two expanded Electronic Associates 16-31R consoles with considerable non-linear equipment. There is also a quantity of BEAC (Boeing Electronic Analog Computer) equipment.

George Castile ran his dry friction simulation for the benefit of Council members, giving a vivid demonstration of points brought out in the discussion following his paper.

Also demonstrated was the simulation of the control system of a drone aircraft complete with "beeper box". Visitors were able to "fly" the drone and watch its progress on a large plotting board.

Everyone who attended this enjoyable and worthwhile meeting was impressed with the hospitality of the University of Wichita and Beech Aircraft.

He Went Thataway:

Eric Weiss to Sun Oil Company in Newton Square, Pennsylvania.

Information (Without Theory)

By the time you read this we hope all who ordered the *Proceedings of the National Simulation Council* will have received their copies*

Those who have not yet ordered this very informative volume are reminded that for $3.00, sent to Simulation Councils, Inc., 3434 La Jolla Shores Drive, La Jolla, Calif., they can get their volume of reprints of eighteen valuable papers.

Mid-Century Instrumatic Corporation (611 Broadway, New York 12, N. Y.) has a novel gimmick for acquainting people with their new MC-5800 "Master Precision Analog Computer," which they say "differs in concept from older computers in two respects: Expandibility and packaging." This gimmick is a set of five color transparencies of their computer and a collapsible cardboard viewer, all in a 3 x 4½" plastic case which would make a good carrying case for credit cards, driver's license, etc., if one should get tired of looking at the pretty pictures. Bob Stern's covering letter also mentions a "new Card-Programmed Diode Function Generator" and "and AM/FM Multiplier with unusual* performance specifications."

*Your Secretary wishes to apologize for the appalling delay in delivery, and to thank you for your very great patience. It wasn't our fault, honest!

*We built an AM/FM multiplier with "unusual" performance specs when I was at Pt. Mugu. The performance was so unusual, in fact, that we gave up the whole idea!—Ed.

Computer Events

Association Internationale pour le Calcul Analogique

Dates: 1-7 September 1958
Place: Strasbourg, France
Subject: "Journées Internationales de Calcul Analogique"
An exhibit of analog equipment will open 30 August and continue until 10 September. Because of increasing interest in the combination of analog and digital techniques, a section of the "Journées" will be devoted to this subject. For further information write Monsieur F. H. Raymond (133 Boulevard de Verdun, Courbevoie, Seine, France).
Conference rooms will be equipped for simultaneous translation. Discussions following the reading of papers will be in French and English.

Midwestern Simulation Council

Date: 8 September 1958
Place: Caterpillar Tractor Company, Peoria, Illinois
Subject: "Land Vehicle Simulation" (tentative)

Central Simulation Council (annual meeting)

Date: 8 September 1958
Place: Midwest Research Institute Kansas City, Missouri
Subject: "The Digital Differential Analyzer—How It Works, How It Is Used"
Election of officers will take place at this meeting.

National Simulation Conference

Dates: 23-25 October 1958
Place: Statler-Hilton Hotel, Dallas, Tex.
The conference will be sponsored by the IRE PGEC and the Dallas Section of the IRE. For further information write J. E. Howard, 2100 Menefee Drive, Arlington, Texas.

Eastern Joint Computer Conference

Dates: 3-5 December 1958
Place: Philadelphia, Penna.

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CONTACTLESS ANNUNCIATOR

New Panapak for monitoring multivariable automatic systems operates without electromechanical relays;

utilizes static-magnetic elements which, being of plug-in design, make it possible to change sequences without rewiring, or to expand annunciator system. Static-magnetic elements are capable of AND, NOT, OR and MEMORY logic functions which cover any arrangement or set of conditions. —*Panellit, Inc.*, 7401 *N. Hamlin, Skokie, Ill.*

For more information circle **210** on inquiry card.

COMPUTING RELAY

New pneumatic relay solves equations continuously by multiplying or dividing one pneumatic signal, repre-

senting one measured variable, by some predetermined function of a second variable. Function-generating cam is easily shaped on the job. Standard unit also adds and subtracts pneumatic signals and provides proportional control action. Relay uses standard SAMA ranges of 3-15 psig and 3-27 psig.—*Bailey Meter Co.*, 1050 *Ivanhoe Rd., Cleveland*, 10, *Ohio.*

For more information circle **211** on inquiry card.

CONTACTLESS ANNUNCIATOR

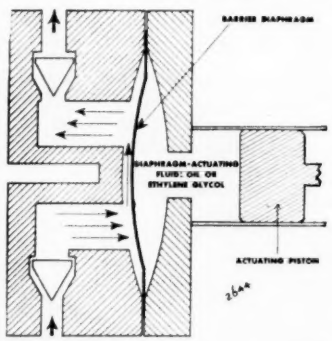
New Scammit audible and visual alarm system operates without electromechanical relays; utilizes static

switching circuit, thereby obviating need of hermetic sealing and assuring extremely long life because of absence of mechanical or electrical failure. Stations take a fraction of space required by conventional relay systems. Six-unit cabinet illustrated has ⅜" x ¾" backlighted nameplates, with two bulbs in parallel behind each nameplate.—*The Scam Instrument Corp.*, 1811 *W. Irving Park Rd., Chicago* 13, *Ill.*

For more information circle **212** on inquiry card.

PUMPS FOR CORROSIVES

New Kemlon Pumps specifically designed to handle corrosive fluids are available in simplex and duplex mod-



els; feature suction lifts up to 20 ft; standard design pressure 50 psi (much higher special). Unlike most diaphragm pumps, new design is essentially a piston type with a barrier diaphragm separating working parts from fluid handled. Being of positive-displacement type, simplex pumps can be used for metering and duplex pumps for proportioning-and-metering. Variable-speed electric drives (optional) control flow-rates from 1 to 140 gph (simplex) and 5 to 600 gph (duplex).—*The Keystone Engineering Co., P. O. Box* 14366, *Houston* 21, *Texas.*

For more information circle **213** on inquiry card.

THERMOSTAT

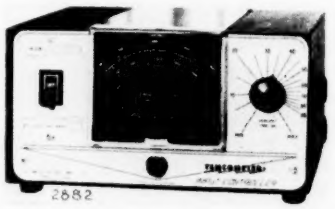
New All-Purpose Thermoswitch with a wide range of industrial applications is particularly useful under

corrosive conditions because of its type 316 stainless steel construction and other features whereby it can be easily changed from one process or experiment to another without loss of sensitivity or performance. Range −100°F to 600°F; rating 10 amp 115 vac non-inductive; available with either make or break contact action on temperature rise.—*Fenwal Inc., Ashland, Mass.*

For more information circle **214** on inquiry card.

TEMPERATURE CONTROLLERS

New version of Temcometer Controller has undergone outward restyling and significant internal

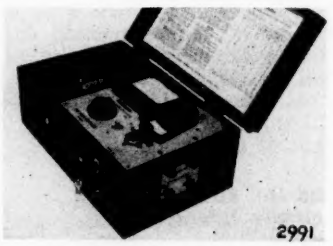


changes. Type 500 units have new-style wide-scale pyrometer with easy-to-read double scale accurately calibrated to 2000°C. Type 500-1 units have a decorative insert in place of pyrometer; are easily converted for temperature indication by replacing insert with a pyrometer. All models incorporate a new heavy-duty switch for extra-long life; new 30- and 34-amp models a rugged industrial contactor; lesser-rating models a heavy-duty relay.—*Thermo Electric Mfg. Co.*, 496 *Huff St., Dubuque, Iowa.*

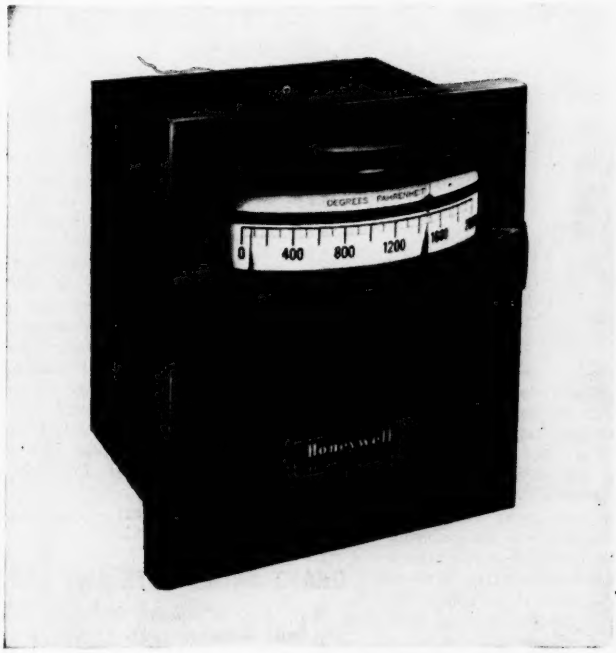
For more information circle **215** on inquiry card.

DEWPOINT INDICATOR

New portable Dewpoint Indicator permits continuous dewpoint measurement; does not require purging of

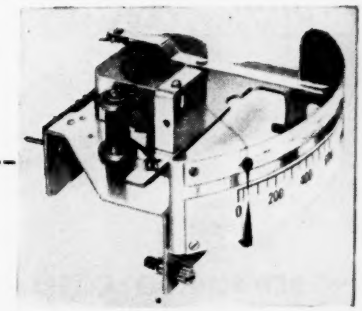


test gas chamber for each reading; gives accurate readings with fast response over a dewpoint temperature



***Pyr-O-Vane* Millivoltmeter Controller**

Available in 150 standard ranges, and a variety of control actions. Both vertical and horizontal models can be flush or surface mounted.

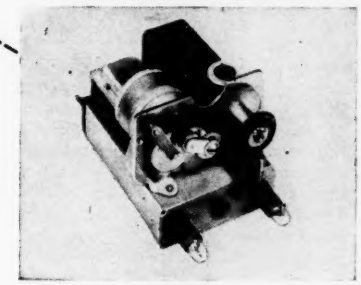


Plug-in galvanometer unit ▲

High-strength *Alnico* magnet makes possible larger gap between magnet and core, reducing clogging due to dirt and dust. Triple ambient temperature compensation provided.

Plug-in pulse *Pyr-O-Vane* control unit

Control units available with choice of 10 different control forms. Proportional band adjustable between 1 and 3%; cycle timing change gears available for 3, 7.5, 12, 18, 30 or 72 seconds. ▼



For economical temperature control

A COMPLETE LINE OF BROWN MILLIVOLTMETERS

CAREFUL attention to design and construction details makes Brown Millivoltmeters accurate—and rugged enough to *stay* accurate in hard use. They give reliable, low-cost temperature control for any heat-using process that doesn't require a chart record.

True plug-in design makes maintenance easy. You can change galvanometers and control units in *less than a minute.*

Choose Brown Millivoltmeters from 150 standard ranges and scales . . . for any safety or control application. And you can have a choice of either horizontal or vertical cases.

With Honeywell's complete line, there's no need to shop around for your various millivoltmeter accessories . . . from thermocouples and *Radiamatic* detectors to motorized valves and dampers.

Your nearby Honeywell field engineer will be glad to discuss your specific needs. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Products Group,* Brown Instruments, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

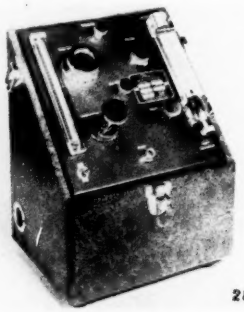
H HONEYWELL First in Controls

range from −100°F to maximum ambient of 110°F; is powered by a self-contained battery. Gas connections are easily made with ⅛" pipe fittings.—*Weighing & Control Components, Inc., 645 Lincoln Ave., Hatboro, Pa.*

For more information circle **216** on inquiry card.

DEW-POINT APPARATUS

New Dewpointer 7200 measures dew-point of gases under pressure over range of room temperature down

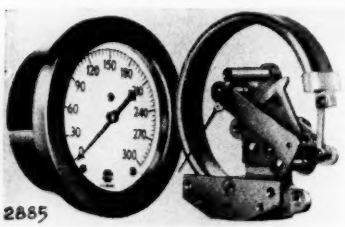


to −80°F; is appropriate for applications on instrument air lines, gas pipe lines, bottled gas, etc.; obviates need of hand pumping for purging and adjustment of pressure ratio; incorporates a by-pass valve and rupture discs as safety devices.—*Illinois Testing Labs., Inc., 420 N. La Salle St., Chicago 10, Ill.*

For more information circle **217** on inquiry card.

PRESSURE GAGES

New A-Line models, modern counterports of USG's general-purpose 500 Series, feature important im-

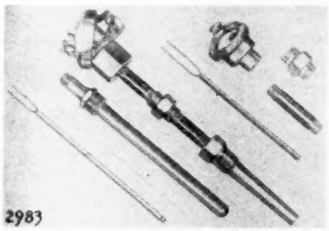


provements and optional extras; meet ASA Grade A standards with guaranteed accuracies within 1% of scale range for middle (working) half of scale, and 1½% of scale for remainders. Internals are removable as one unit (except in 3½" dial size). This "Mono-Unit" construction prevents pointer shift due to stresses at gage connection. Dial sizes 3½", 4½", 6", 8½" and 12"; ranges from 10,000 psig down to 30" Hg vacuum, also compound ranges.—*United States Gauge Div., American Machine & Metals, Inc., Sellersville, Pa.*

For more information circle **218** on inquiry card.

PRESSURE PICKUPS

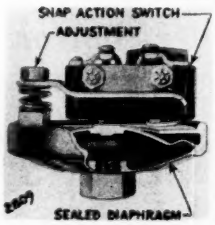
Three new pressure pickups: (1) Model 22005 for high-sensitivity absolute pressure measurements features



resolution 0.0002 or less, hysteresis better than 0.3%, repeatability better than 0.3%, high-temperature operation, low vibration and steady-state acceleration error. (2) Model 22008 is designed to measure pressures in extreme environments; (3) Model 22002 provides non-linear functions; both have a temperature range from −54°C to 100°C with performance that will not vary more than 1% over rated range at 100°C.—*Technology Instrument Corp. of California, 7229 Atoll Ave., N. Hollywood, Calif.*

For more information circle **219** on inquiry card.

SKELETON PRESSURE AND VACUUM SWITCHES

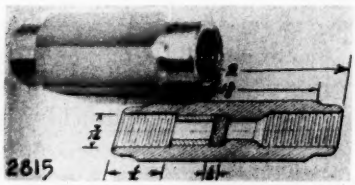


New stripped Model 402 switches have same operating characteristics as Models 420 and 421; operate in any position; are not sensitive to vibration; range limits 30" Hg vacuum and 100 psig. UL-listed sp-dt switching elements for ac and dc circuits are automatically reset by switches' snap-action.—*Barksdale Valves, Pressure Switch Div., 5125 Alcoa Ave., Los Angeles, Calif.*

For more information circle **220** on inquiry card.

PRESSURE SNUBBER

New pressure snubber with two ¼" NPT female pipe connections is fabricated of stainless steel and can



be used with oils, water or steam, and gases. Max operating pressure 20,000 psi. Specials for pressure up to 60,000 psi and for use on aircraft are also offered.—*Chemiquip Co., 36 E. 10th St., New York 3, N. Y.*

For more information circle **221** on inquiry card.

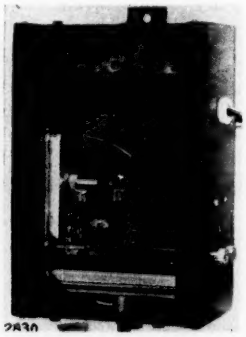
SERVOMANOMETER

New Model 560IN-D Servomanometer with stainless steel tube and high-pressure construction was designed for pressure measurement operation at 10,000 psi and was tested at much higher value. There are now 38 standard Servomanometers, in five ranges from 32" to 120", some of which can be supplied with stainless steel manometer tubes. They can employ any manometer liquid; offer resolution of better than 0.0005" and nominal accuracy of 0.004" or 0.01% of reading.—*Exactel Instrument Co., 5545 Eva Ave., Los Altos, Calif.*

For more information circle **222** on inquiry card.

DRAFT GAGES WITH SWITCHES

New line of gages for indicating and controlling pressure or gas or air have a magnetic type mercury switch



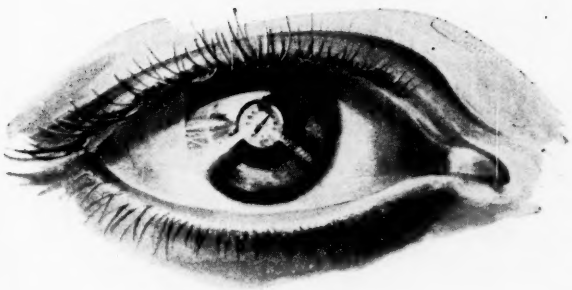
for operating an alarm or signal light; can be furnished with two switches for high or low contacts, also with transformer, bell or light for 110 or 220 v.—*Ellison Draft Gage Co., 540 W. Monroe St., Chicago 6, Ill.*

For more information circle **223** on inquiry card.

PRESSURE SWITCH

New Cat. 161 pressure switch for control from 0.1 to 15 psi, is available in five classes of switches. Pressure setting is readily adjustable in the field. Units are suitable for any fluid not harmful to neoprene diaphragm. Standard proof pressure 25 psi (higher to order). Terminals are fully enclosed; ratings of sp-dt switch 15 amp @ 120-250 vac.—*The Henry G. Dietz Co., 12-16 Astoria Blvd., Long Island City 2, N. Y.*

For more information circle **224** on inquiry card.



What you read is right

The new, patented Maxivision dial on American Bi-Metal Thermometers eliminates the perspective effect of usual pointer-above-dial construction. No parallax! Readings are sure, sharp and accurate – exact working temperatures are always right before your eyes. It is a two-level dial. A raised outer ring, set close to the cover glass, carries the graduations. The index type pointer is on the same plane as the outer ring, with the numerals on a lower level.

What you read is right when American Bi-Metal Thermometers with anti-parallax Maxivision dial are installed at important check points on your processing facilities. Mounting styles, dial sizes, temperature ranges and stem lengths are available to meet the most exacting requirements. Let your nearby industrial distributor help you select the best combination for each location.

American Bi-Metal Thermometer with Maxivision Dial. Suitable for indoor or outdoor service.

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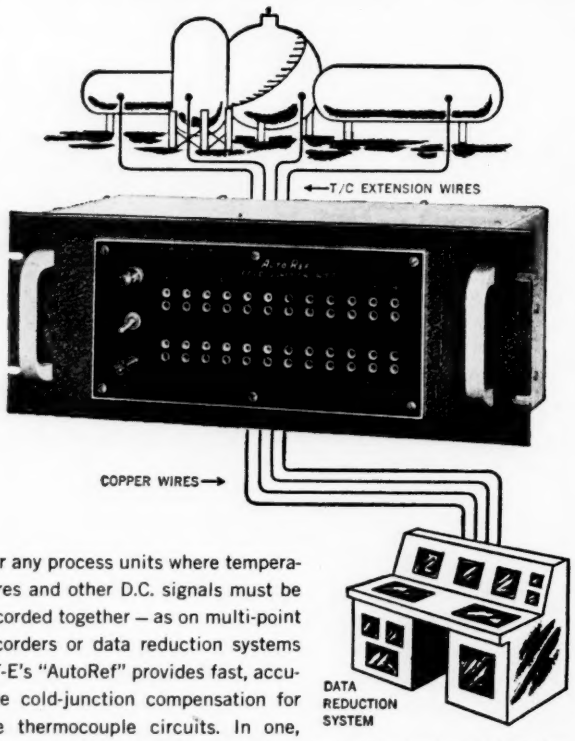
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

For more information circle **73** on inquiry card.

T-E's *AUTOREF*® Provides

Cold Junction Compensation For Many Thermocouples

Ideal For Data Reduction Systems



For any process units where temperatures and other D.C. signals must be recorded together – as on multi-point recorders or data reduction systems –T-E's "AutoRef" provides fast, accurate cold-junction compensation for the thermocouple circuits. In one, compact unit it gives you constant, pre-determined, cold-junction reference for many thermocouples – actually up to several hundred. Typically, cold-junction temperatures can be controlled to within ±1°F. over a wide range of ambient temperatures.

Besides its accuracy, the "AutoRef" offers tremendous convenience – saving both time and effort. Designed for panel rack mounting, it can be introduced anywhere in the thermocouple circuit – no matter where thermocouples and instruments are located. Whenever temperatures, pressures, flow-rates and other electrical and mechanical conditions are being recorded simultaneously, the "AutoRef" does away with the need for maintaining ice baths or making laborious correlations. It is available for all standard thermocouple calibrations.

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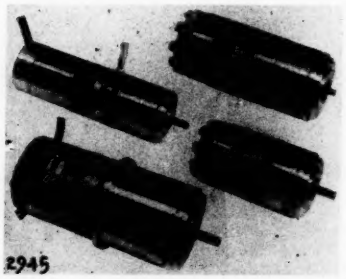
SADDLE BROOK, NEW JERSEY
In Canada — THERMO ELECTRIC (Canada) Ltd., Brampton, Ontario

For more information circle **74** on inquiry card.

NEW INSTRUMENTS

TACHOMETRIC PICKUPS

New Servomotor-Tachometers find application as precise integrators in many mathematical computations de-



manding 0.01% accuracy; feature 0.03% to 0.1% output voltage linearity, no frequency change between input and output voltages, stable output voltages over specified temperature range, and extremely low harmonic distortion of output voltages. Compensating networks designed to minimize errors attributable to frequency variations are available.—*Kearfott Co., Inc.*, 1378 *Main Ave., Clifton, N. J.*

For more information circle **225** on inquiry card.

FREQUENCY-TO-VOLTAGE CONVERTER

New Series 1220 Frequency to DC Converters accept inputs from impeller-type flow-rate pickups and con-

vert input frequencies to a dc voltage with accuracy and stability better than 0.1%. Selectable time constants from 1 ms to 2 sec; full-scale frequency ranges of 500, 2500, and 10,000 cps; 1 to 5 channels per 19" rack. Photo shows 6-unit Model 1226. —*Systron Corp.*, 2055 *Concord Blvd., Concord, Calif.*

For more information circle **226** on inquiry card.

MOTOR TACHOMETER

New unit combining a standard BuORD size 11 motor an integral high-performance 400-cps damping tachometer in a casing 2 19-32" long; provides a particularly compact and versatile means of systems stabilization; was designed primarily for low-inertia low-consumption damping applications, and high-temperature reliability (125°C ambient).—*Servomechanisms, Inc.*, 1200 *Prospect Ave., Westbury, L. I., N. Y.*

For more information circle **227** on inquiry card.

REMOTE GAS METER READING DEVICE

New Impulse Contactor enables receiving all gas meter readings in one central office, is used in combination

with Emcorector that provides direct volume reading at base contract pressure without need to correct for line pressure.—*Gas Products Div., Rockwell Mfg. Co., Pittsburgh 8, Pa.*

For more information circle **228** on inquiry card.

DUAL SWITCH TEMPERATURE CONTROLLER

New Type D70A Dual Switch Temperature Control permits switch action above or below set point, control of two independent circuits and extreme flexibility of switching arrangement; features micrometer-type temperature-setting knob-and-barrel; individual adjustment of switches by independent recessed hexhead screws. On-off differentials are between 1F° and 2F°.—*United Electric Controls Co., 79 School St., Watertown, Mass.*

For more information circle **229** on inquiry card.

DUAL SPEED GOVERNOR

New type of speed governor for maker's permanent-magnet dc Types MM and LL motors can provide two

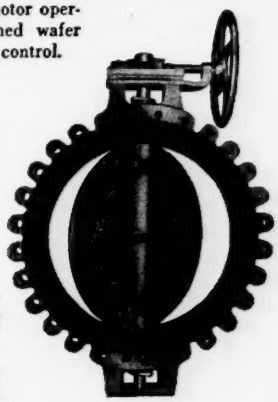
regulated speeds within speed capacity of motor with which it is used (generally about 4,000 to 15,000 rpm) each speed set by a separate adjusting screw. Motor can be reversed by reversing polarity of applied voltage. Governor fits inside the 1¼" OD cover which encloses motor, and adds about ⅝" to motor length.—*Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.*

For more information circle **230** on inquiry card.

for heavy duty service

ROCKWELL "WAFER" VALVES

Wafer valve with air motor operator. *Right*—rubber-lined wafer valve with hand wheel control.



Compact, space-saving butterfly valves for dependable throttling and wedge-tight shut-off of air, gas, liquids and semi-solids at differential pressure to 150 psi and temperatures from minus 50° to plus 600°F. and higher. Manual or automatic operators. Standard sizes to 36" and larger special sizes. Write for Bulletin 580.

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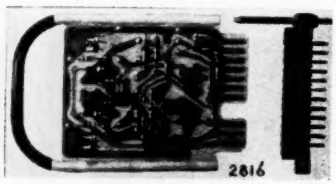
For more information circle **76** on inquiry card.

NEW INSTRUMENTS

SHIFT FLIP-FLOP

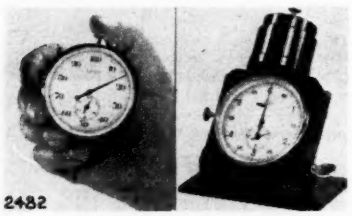
New Model SF 101, added to 3C-PAC Series M transistorized digital plug-in packages, is designed specifically for use in digital shift registers and does not require use of additional components or circuitry in such applications. It comes with 12-pin printed-circuit connector with polarizing guide pin. Handle is color-coded.—*Computer Control Co., Inc., 92 Broad St., Wellesley, Mass.*



For more information circle **231** on inquiry card.

LAB STOP WATCHES

New Jaquet (Swiss) laboratory stop watches for electrical and manual operation withstand wear in labs where watches are used hundreds of times a day. Dial size is 2.36".—*Herman H. Sticht Co., Inc., 27 Park Pl., New York 7, N. Y.*



For more information circle **232** on inquiry card.

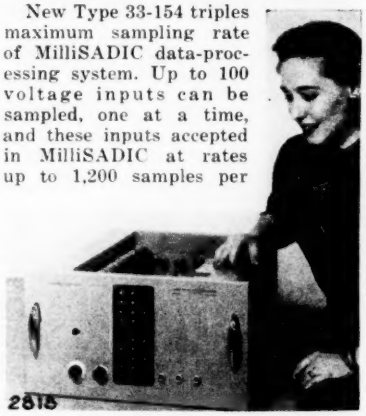
FRACTIONATING DISTILLATION APPARATUS

New U-1114 Unitized Spinning Band Column is fabricated from Pyrex Brand glass. Vacuum jacket is strip-silvered to provide a full-length observation window. Automatic Liquid Dividing Head eliminates heat losses around ground joints. Reflux is directed to liquid take-off valve by means of a coiled condenser. Among other features: panel-mounted motor, motor controller, Flexopulse Timer, Pirani vacuum gage and flash heater mantle with ammeter. Ready for immediate operation on 110 vac.—*Stanford Glassblowing Labs., 971 Commercial St., Palo Alto, Calif.*

For more information circle **233** on inquiry card.

HIGH-SPEED COMMUTATOR

New Type 33-154 triples maximum sampling rate of MilliSADIC data-processing system. Up to 100 voltage inputs can be sampled, one at a time, and these inputs accepted in MilliSADIC at rates up to 1,200 samples per second.—*Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.*



For more information circle **234** on inquiry card.

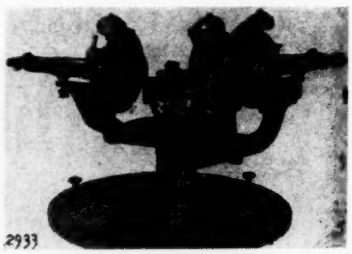
GEIGER-MUELLER TUBE

New Genalex Type GM4LB features extremely low background count; can detect minute amounts of beta radiation, at energy levels of 0.1 mev and above. Background as low as 0.4 count per minute is possible, when operated in a shielded enclosure, with an anti-coincidence guard ring. Thin aluminum 1"-dia end window weighs 7 mg/cm². Operation is at 1200 to 1400 v with plateau length of 150 to 200 v and average slope of .05%/v.—*Dept. K42, British Industries Corp., Port Washington, N. Y.*

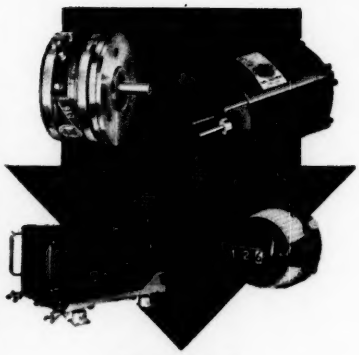
For more information circle **235** on inquiry card.

ELLIPSOMETER

New Ellipsometer, for investigation and measurement of thin films by use of elliptically polarized light, is also adaptable to study of birefringence, index of refraction, etc. Three models: L118 has four $\frac{3}{8}$" circles divided in degrees and reading to 1.1°; two circles have 14-mm Nicol prisms and the third a quarter-wave plate. L118GT is the same except with 14-mm Glan Thompson prisms. L119 has six ¼" circles reading by opposed verniers to 0.01°; polarizer and analyzer are 14 mm Glan Thompson prisms and compensator is a quarter-wave plate.—*Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill.*



For more information circle **236** on inquiry card.



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Crystal controlled oscillator type frequency standards.

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For more information circle **77** on inquiry card.

STANDARD COMPONENTS

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Design flexibility of standard Borg components often eliminates the need for expensive, specially designed units. Borg offers a complete line of precision potentiometers, turns-counting dials and fractional horsepower motors. Many of these standard Borg components are currently on duty in missile launching platforms and firing control stations, radar and sonar equipment, computers and similar electronic apparatus. Production of standard Borg components assures quick delivery. A partial selection is shown on this page. Write for complete data on all Borg components. Ask for catalog BED-A90.

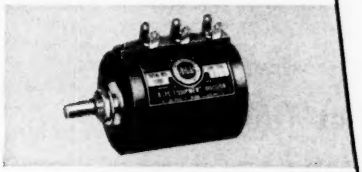
205 SERIES, 10-TURN MICROPOTS

SIZE: 1¾" dia.; 2⅛" long; shaft extension ⅞" or special to order.

LINEARITY ACCURACY: ±0.1% and 0.05% (independent or zero based).

RESISTANCES: 50 ohms to 100,000 ohms, tolerance ±5%.

POWER DISSIPATION: 5 watts at 40° C.



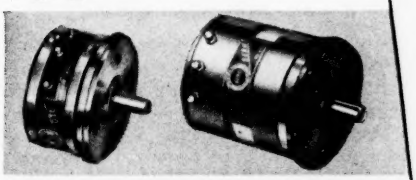
1100 SERIES, 10-TURN MICROPOTS

SIZE: 1⅞" dia.; 2⅛" long; shaft extension ⅞" or special to order.

LINEARITY ACCURACY: 0.5% to 0.1% (independent linearity).

RESISTANCES: 50 to 100,000 ohms, tolerance ±5%.

POWER DISSIPATION: 3 watts at 40° C.



900 SERIES MICROPOTS

Borg 900 Series Micropots are available in single-turn, 3-turn and 10-turn models.

SIZE: Single-turn — 2" dia.; 1$^{5}/_{64}$" long
3-Turn — 2" dia.; 1$^{5}/_{8}$" long
10-Turn — 2" dia.; 2$^{1}/_{16}$" long
Shafts — ¼" dia.
Bushing Mount — ⅞" long
Servo Mount — ⅝" long

LINEARITY ACCURACY: Single-turn — ±.5% (independent)
3-Turn — ±0.1% (independent, zero based, or absolute reference).
10-Turn — .05% (independent, zero based, or absolute reference).

RESISTANCES: Single-Turn — 50 to 50,000 ohms
3-Turn — 15 to 60,000 ohms
10-Turn — 50 to 300,000 ohms

TEMPERATURE LIMITS: Tested to 350° F.

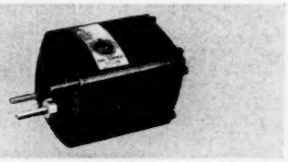
990 SERIES TRIMMING MICROPOTS

SIZE: 1¼" x $^{5}/_{16}$" x $^{17}/_{64}$"

RESISTANCES: 10 to 30,000 ohms standard. Other values on special order.
Tolerances — ±5% 100 ohms and over
±10% below 100 ohms

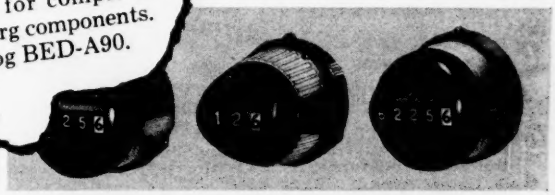
ADJUSTMENT: Screw driver slot provides adjustment of complete range in 40 turns.

TERMINALS: Printed circuit, soldered lug, insulated wire leads.



PRECISION INSTRUMENT MOTORS

Borg-Motors offer you fractional horsepower motors in synchronous or induction models with or without gear-trains in 2-pole or 4-pole models for your precision equipment. Borg-Motors are totally enclosed, using precision machined die cast alloys for end bells and gear train cases. Die cast rotors, mounted on two ball bearings, assure long life, continued accuracy.



DIRECT READING MICRODIALS

Borg Direct-Reading Microdials provide the highest accuracy of perception when forced-fast-reading and setting is required because of their inline digital presentation. Borg Direct-Reading Microdials are available in 3-digit 10-turn models, 4-digit 100-turn models and 5-digit 1,000 turn models. Also available are Borg Concentric Scale Microdials which indicate the position of any multi-turn device of 10 turns or less.

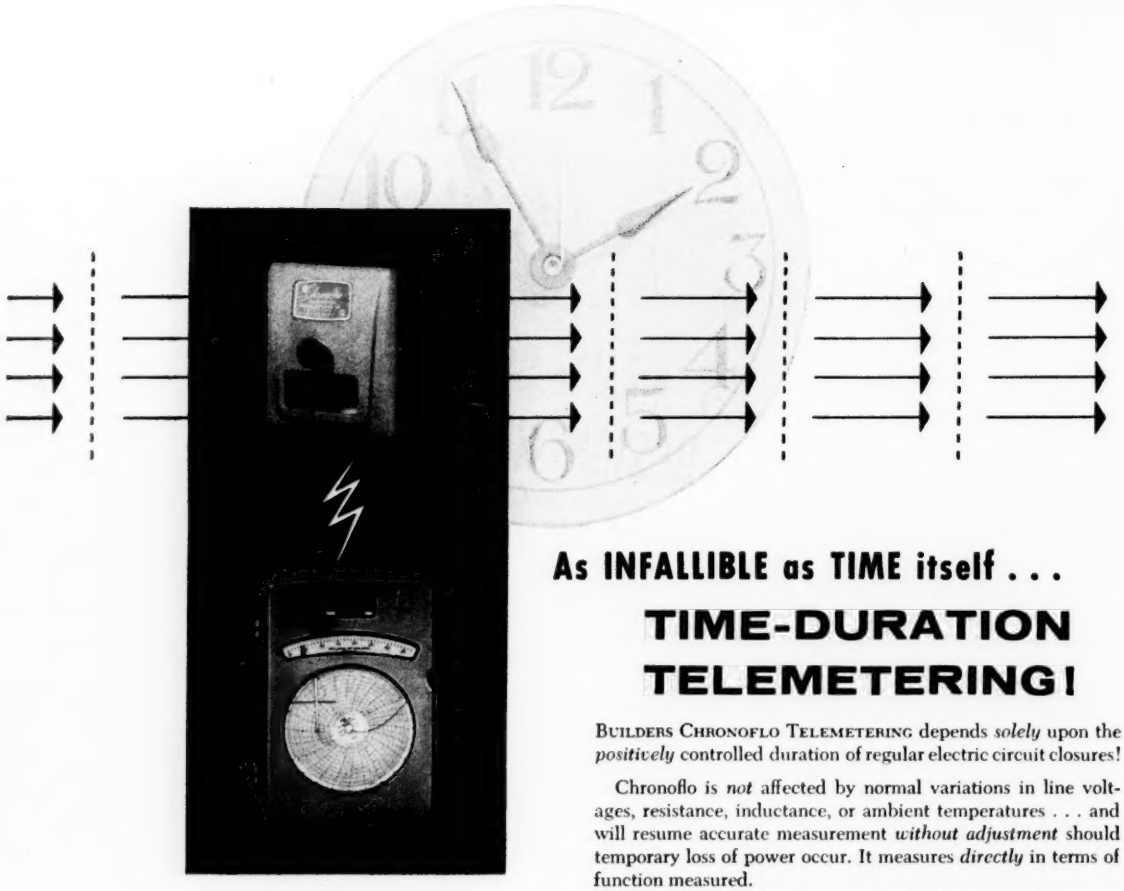
WRITE FOR COMPLETE DATA ON ALL BORG COMPONENTS — CATALOG BED A90

BORG EQUIPMENT DIVISION
The George W. Borg Corporation
JANESVILLE, WISCONSIN

BORG®

- MICROPOTS
- MICRODIALS
- MOTORS

POSITIVE CONTROL OF MATERIALS IN MOTION B·I·F METERS FEEDERS CONTROLS



As INFALLIBLE as TIME itself . . .

TIME-DURATION TELEMETERING!

BUILDERS CHRONOFLO TELEMETERING depends *solely* upon the *positively* controlled duration of regular electric circuit closures!

Chronoflo is *not* affected by normal variations in line voltages, resistance, inductance, or ambient temperatures . . . and will resume accurate measurement *without adjustment* should temporary loss of power occur. It measures *directly* in terms of function measured.

Chronoflo, used in supervisory control systems, integrates readily into data reduction, tone and/or micro-wave transmission, and similar systems dependent upon electrical transmission media. It brings these systems the many advantages time-duration telemetering has over impulse signal types. With Chronoflo, any of the following functions can be performed more *accurately*, more *dependably*, and more *economically:*

- **REMOTE METERING**
- **IN-PLANT CENTRALIZATION**
- **REMOTE CONTROL**
- **MULTI-FUNCTION METERING**
- **AUTOMATIC CONTROL of time-duration actuated equipment.**

ASK FOR PROOF!

Builders-Providence pioneered time-duration telemetering over 25 years ago . . . and now offers you the experience gained in engineering thousands of performance-proved installations. Prove how this system can make your installation more *accurate*, more *dependable*, and more *economical!* Request Bulletin 230-H4A. Write **Builders-Providence, Inc., 42½ Harris Ave., Providence 1, Rhode Island.**

NEW LITERATURE

Please send me the POSITIVE FLOW CONTROL bulletins checked below:

- ☐ Shuntflo Bulletin (400-J10A) . . . for metering air, gas, steam
- ☐ Propeloflo Bulletin (380-K4B) . . . for metering water
- ☐ Conveyoflo Bulletin (550-P5) . . . for weighing belt-conveyed materials
- ☐ Chronoflo Bulletin (230-H4B) . . . for telemetering and control
- ☐ Venturi Flow Nozzle Bulletin 130-E2A . . . for high pressure, high temperature metering
- ☐ Dall Flow Tube (DFT-P1) Bulletin 115-R1 . . . for low cost, specialized metering

Name .....

Company .....

Address .....

City ..... *State* .....

BUILDERS-PROVIDENCE
DIVISION OF
B-I-F INDUSTRIES B·I·F METERS FEEDERS CONTROLS

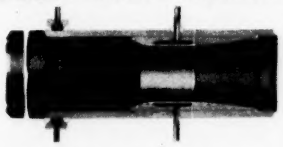
For more information circle **78** on inquiry card.

SPECIFY BIF

FLOW METERING ELEMENTS FOR CORROSIVE FLUIDS

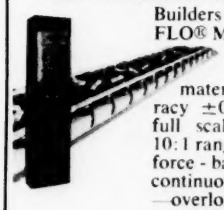
Builders Model DFT-PI Dall Flow Tube . . . insert-type, plastic primary metering element. Low cost, accurate. Suitable for most applications, especially corrosive fluids. Bulletin 115-R1.

FOR HIGH PRESSURES & TEMPERATURES



Builders X-TRA-HI Flow Meters . . . for high temperature, high pressure applications . . . proven in primary loop of every major atomic reactor in America. Bulletin 130-E2A.

DRY MATERIALS METERING

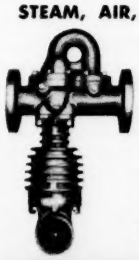


Builders CONVEYO-FLO® Meter . . . totalizes belt-conveyed materials — accuracy ±0.5 of 1% of full scale load over 10:1 range. Pneumatic force-balance system continuous integration —overload protection — explosion-proof. Bulletin 550-P5.

LIQUID METERING

Builders PROPELOFLO® Meter . . . direct-reading, propeller-type liquid meter . . . 2" to 20" lines . . . within ±2% of actual flow over specified range . . . capacities ranging from 15 to 5,800 GPM. Bulletin 380-K4B.

STEAM, AIR, GAS METERING



Builders Shuntflo Meter . . . self-contained, self-operated meter . . . for 1" to 24" line sizes . . . accurate within ±2% of actual rate of flow. Provides continuous and automatic pressure compensation. Bulletin 400-J10A.

MAIL COUPON TODAY!

For more information circle **78** on inquiry card.

NEW INSTRUMENTS

7-DECADE SCALER

New Model 131A cold-cathode glow-tube scaler for general-purpose radioactivity counting (a new version of original Dekatron) is designed for integral pulse height analysis in scintillation or proportional counting; provides reliable counting with high capacity and continuously variable preset timing; features as a 7-decade capacity and a built-in timer; contains an ultralinear ultrastable expander amplifier type pulse height selector; has a resolving time of <5 usec with an electronic scale of 1,000 followed by a 4-digit electromechanical register; weighs 30 lb, measures 19" w x 5¼" h x 17" d; can be used with any compatible B-A preamplifiers and high voltage supplies to form ultrastable counting systems. —*Baird-Atomic, Inc., 33 University Rd., Cambridge 38, Mass.*

For more information circle **237** on inquiry card.

VACUUM THERMO BALANCE

2804

New Thermo-Grav, first American-made vacuum thermo balance, records thermogravimetric curves of sample in vacuum or controlled atmospheres at temperatures up to 1000°C; comprises a precision spring balance enclosed in a glass chamber; two furnaces; displacement pickup and recording system; and automatic temperature-time programming.—*American Instrument Co., 8030 Georgia Ave., Silver Spring, Md.*

For more information circle **238** on inquiry card.

SAMPLE-HOLD MULTIPLEXER

New Model EM-51S high-speed electronic sample-hold multiplexer, a system building-block designed to facilitate data control, time-multiplexes five voltage inputs to a single voltage output. Several can be interconnected to produce a single voltage output. EM-51S is directly compatible with, and designed for, maker's high-speed DATRAC voltage-to-digital converters. Unique sample-and-hold feature makes possible the simultaneous sampling within 0.2 usec of any number of channels of highly dynamic data. Max channel-to-channel multiplexing rate is 25 kc.—*Epsco, Inc., 588 Commonwealth Ave., Boston 15, Mass.*

For more information circle **239** on inquiry card.

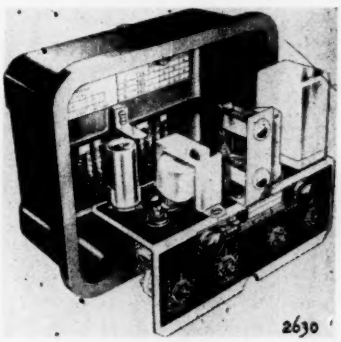
PHASE-LOCK DEMODULATOR

New Model 8-100 offers major gain in telemetering receiver sensitivity by lowering improvement threshold by at least 6 db when all RDB subcarriers are received. When fewer channels are used, threshold is lowered even more. Honest system gain thus provided can be traded for increased range, reduced transmitter power, decreased antenna gain, or increased safety factor. Demodulator is designed for use with standard 1400 Series receivers but can be modified for use with others. It is installed by a simple plug-in connection and no receiver modification is required.—*Radiation, Inc., P. O. Box 37, Melbourne, Fla.*

For more information circle **240** on inquiry card.

LIQUID LEVEL CONTROLLER

New two-position Type 2408W, for use in liquids with dielectric constant of 80 or more or specific conductance



2630

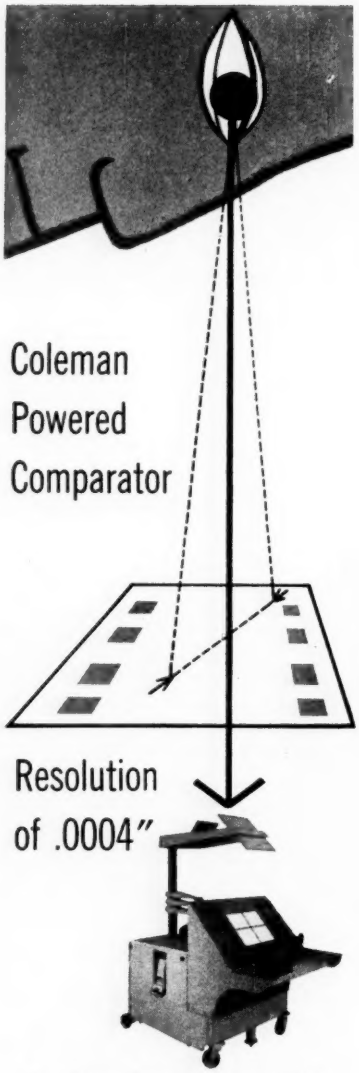
of 4 micromhos or more, can operate with coaxial cable lengths up to 200 ft between control unit and epoxy-phenolic-resin-coated capacitance probe whose limits are 150° F and 2500 psi. ★Alarm version, Type 2414W, utilizes same operating principle as automatic controller.—*Fisher Governor Co., Marshalltown, Iowa.*

For more information circle **241** on inquiry card.

PUNCHED-CARD SENSOR

New K-1 Sensor accepts a standard punched card (540 positions arranged 12 wide by 45 high) and, when handle is closed, each circuit corresponding to an unpunched hole position is opened. Handle actuates Sensor by pressing the card over spring-loaded Teflon pins. Each potential hole position has a corresponding spring-loaded Teflon pin and sp-st- n-c switch. Where there is a hole in card, corresponding switch stays closed. Where there is not a hole, Teflon pin is pushed forward by card and opens a switch. Over-all dimensions about 6¼" w x 9" d; weight about 18 lb.—*Metron Corp., 8 Coryell St., Lambertville, N. J.*

For more information circle **242** on inquiry card.



The Coleman Powered Comparator, a high precision electro-mechanical data reduction machine, measures and records distance between points and angular position of images on 16 mm, 35 mm, 70 mm, or 5½" film or plates. Measures image position with resolution of .01 mm to an overall accuracy of one part in 14,000. Automatically records in digital form for electric typewriters, punched card, or perforated tape machines.

Write for free Data File. Mention your application.

Your name_____

Company_____

Address_____

Coleman

ENGINEERING COMPANY, INC.
6040 West Jefferson Boulevard
Los Angeles 16, California

For more information circle **79** on inquiry card.

NEW INSTRUMENTS

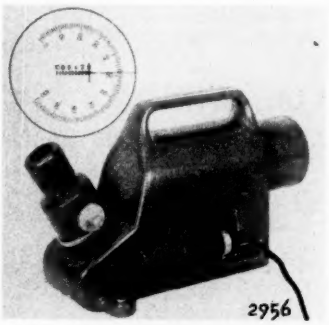
INDUCTION-HEAT GENERATOR

New Dual Frequency Generator, added to maker's line of high-frequency induction heating units, is rated at 10 kw of output power. Lower frequency range 250 to 600 kc, higher about 2 to 5 Mc, providing flexibility and obviating need of purchasing two generators. Megacycle frequencies are ideal for heating semi-conductor materials, superficial heating, etc.—*Lepel High Frequency Labs., Inc., Woodside, N. Y.*

For more information circle **243** on inquiry card.

AUTO COLLIMATOR

New precision Auto-Collimator made by Leitz-Wetzlar (West Germany) departs from traditional tele-

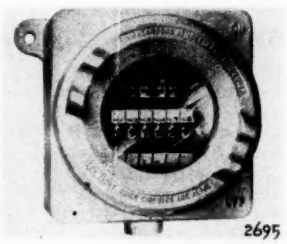


scope design; is independent of any mounting fixture: even ocular is rotatable against stops over an exact 90° quadrant for measurements in two planes.—*Opto-Metric Tools, Inc., 137 Varick St., New York 13, N. Y.*

For more information circle **244** on inquiry card.

MINIATURE EXPLOSION PROOF ANNUNCIATOR

New Model ST-EM six-alarm-point explosion-proof annunciator meets Class 1, Div. 1 requirements; is 6" x



6½" x 7" over-all; features new Scammit static switching circuit comprising silicon diodes and thermistors for trouble-free reliability. Two bulbs in parallel for each alarm point assure constant monitoring.—*The Scam Instrument Corp., 1811 W. Irving Park Rd., Chicago 13, Ill.*

For more information circle **245** on inquiry card.

HAND SIGHTING LEVEL

New level, factory calibrated to 20-minute-of-arc accuracy, is used like a telescope: coincidence of bubble,

reticle and object determines exact eye-level.—*Edmund Scientific Co., Barrington, N. J.*

For more information circle **246** on inquiry card.

RADIATION ANALYZER

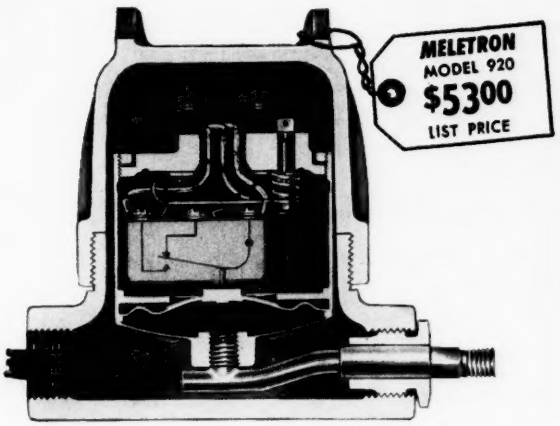
New Detectolab Model DZ46 Automatic Gamma Ray Spectrum Recorder features operational simplicity;

automatic single or repetitive scan; front panel selection of five scanning speeds and of scanning limits; and automatic repetitive charting with no mirror image; can evaluate isotope mixtures with energy difference of as little as 75 kev without chemical separation.—*BJ Electronics Borg-Warner Corp., 300 Newport Blvd., Santa Ana, Calif.*

For more information circle **247** on inquiry card.

POSITIVE DISPLACEMENT METER TELEMETERING

New Pulse-Code Positive-Displacement Meter Telemetering System displays meter readings at receiver in digital form to six places on 8-section horizontal read-out window; two remaining spaces numerically identify meter being read. Meter selection is by 'phone dial; reading cycle is completed in seven seconds. Transmitters input can be electrical (pulse or contact) or mechanical (direct drive). Distance from transmitters to receiver is unlimited. All major components of receiver are plug-in. Each character of display is optically projected onto front window, eliminating ghost images. System components are compatible with pulse-code telemetering systems for remotely indicating liquid



Here's the Simplest Diaphragm Pressure Switch for Explosive Atmospheres

WE BUILD IN	WE DON'T USE
EXTREME ACCURACY and DEPENDABILITY maintained during operating life due to direct acting design	**LINKAGES & BEARINGS** which, as they wear, make the setting of the pressure switch drift.
OPERATION IN ANY POSITION which saves the installation costs encountered in mounting a switch that uses liquid switching elements.	**LIQUID SWITCHING ELEMENTS** which make the switch difficult to mount and very critical to vibration.
IMMUNITY TO VIBRATION you can mount the switch directly on your vibrating or moving equipment.	**ACCORDION DIAPHRAGMS** which make the pressure switch sensitive to vibration.

ask for bulletins 920-925

PRESSURE SWITCH DIVISION

barksdale valves

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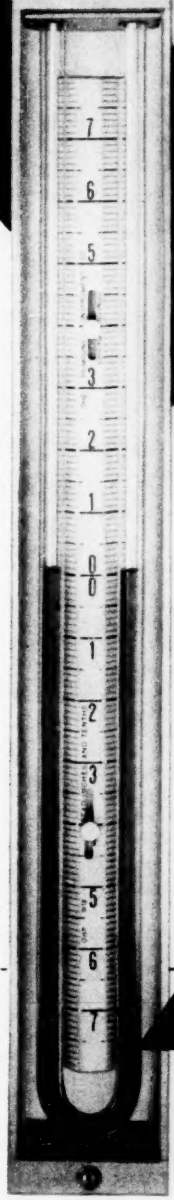
For more information circle **80** on inquiry card.

NEW!

from TRIMOUNT

MODEL F-30 U-TUBE MANOMETER



THE ULTIMATE IN ACCURACY AND CRAFTSMANSHIP!

The most demanding requirements of engineers and technicians have been fulfilled with the Trimount Model F-30 U-Tube Manometer! New and compact in design, the Model F-30 incorporates every known advance relative to U-Tube Manometer construction. The body is of extruded aluminum and the head is easily removed for cleaning. Overall design is clean and modern, contributing outstanding readability ease and accuracy. Other features of the Trimount Model F-30 U-Tube Manometer emphasize the inherent accuracy, dependability and versatility of this precision instrument.

ONLY FROM TRIMOUNT... A LOW COST MANOMETER WITH THESE QUALITY FEATURES:

RANGE: 6" to 60".
SCALE: English or Metric Units.
CONSTRUCTION: Open, or fully enclosed with glass cover.
FINISH: Gold anodized aluminum.
CONNECTIONS: ¼" NPT for Top, Side, or Back Connecting.
MOUNTING STYLES: Bench, Wall, Front of Panel, or Flush Panel.

FLUID CONTACTED PARTS

Model F-30 . . . Steel and Pyrex.
Model F-31 . . . Brass and Pyrex.
Model F-32 . . . 18-8 Stainless Steel and Pyrex.

Above specs regarding range, scale, etc. apply to all three models.

WRITE FOR CATALOG AND FULL INFORMATION.

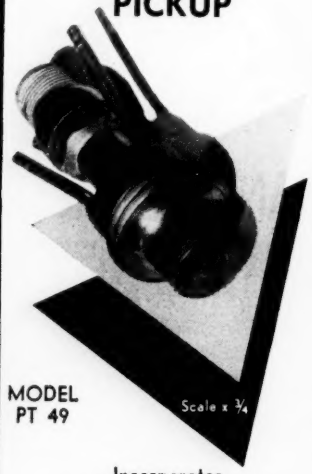
TRIMOUNT INSTRUMENT COMPANY
Dept. IA-88,
3119 West Lake Street, Chicago 12, Ill.

Gentlemen: Please send me full information regarding the Trimount line of Manometers, including the Model F-30.

Name .....
Title .....
Company .....
Address .....
City ..... Zone ... State .....

Dynisco

Water-Cooled
PRESSURE
PICKUP



Incorporates
Unbonded Strain Gauge

HIGHLIGHTS

► DIAPHRAGM TEMPERATURES IN EXCESS OF 6000°F

► FLUSH-MOUNTED PRESSURE DIAPHRAGM

►30,000 CPS NATURAL FREQUENCY

► ½ % ACCURACY

► HIGH OVERLOAD PROTECTION

► MINIATURIZATION

PRESSURE RANGES
0-500 to 0-2000

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NO. 149

For more information on Dynisco pressure, force, flow, and displacement pickups,

write:

DYNAMIC INSTRUMENT CO.
42 Carleton Street
Cambridge 42, Mass.
UN 4-7260

For more information circle **82** on inquiry card.

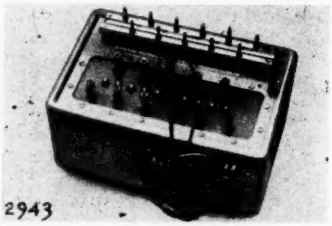
NEW INSTRUMENTS

level, temperature, etc., for remote control of valves, motors, etc., data scanning and logging, alarm condition signals and transmission of other data as required.—*Vapor Recovery Systems Co., 2820 N. Alameda St., Compton, Calif.*

For more information circle **248** on inquiry card.

RESISTANCE CALIBRATOR

New Resistance Calibrator permits resistance calibrations up to 100 megohms with 0.01% accuracy; em-



ploys method developed by Nat'l Bureau of Standards enabling transfer of accuracy of low-range standards to higher ranges with transfer error of less than 0.0001% per two decades up to 10 megohms and 0.01% to 100 megohms; can be used as a high-precision voltage divider for accurate measurement of small currents, time constants, etc.—*International Resistance Co., Hycor Div., 12970 Bradley Ave., Sylmar, Calif.*

For more information circle **249** on inquiry card.

ULTRASONIC TOOLS

New Glennite Ultrasonic Soldering Iron is designed for soldering, without flux, materials such as aluminum

and magnesium and their alloys; also to avoid corrosive effects of flux. Its vibrations break up oxide layer and enable certain metals and alloys to be effectively soldered without special surface pretreatment. ★New Glennite U-602 ultrasonic drill, with 100-watt power output, supersedes maker's 40-watt drill, is designed for rapid drilling of intricate shapes into hard, brittle, and unyielding materials; operates on a frequency of 20 to 22 kc.—*Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J.*

For more information circle **250** on inquiry card.

CAPACITANCE BRIDGE

New high-speed 1-Mc automatic capacitance limit bridge meets government and commercial testing specs; is

complete with built-in precision standards; enables true high-speed testing with no knobs or dials to turn and green, red and amber lights to indicate good, high and low. Available with semi-or fully-automatic component feeding and sorting mechanisms.—*Industrial Instruments, Inc., 89 Commerce Rd., Cedar Grove, Essex County, N. J.*

For more information circle **251** on inquiry card.

RADAR TEST SET

New Model W 909-1C-A combination X and C band radar test set, identical in function with standard single band models, has a unique stacking arrangement that permits dual performance check; incorporates all four master functions; spectrum analyzer, power monitor, signal generator, and direct-reading frequency meter.—*Kearfott Co., Inc., Microwave Div., 14844 Oxnard St., Van Nuys, Calif.*

For more information circle **252** on inquiry card.

STANDARD PULSE GENERATOR

New Model 179, a general-purpose source of high-amplitude positive and negative pulses with clean shape, provides continuously-variable output pulse amplitude; features wide calibrated frequency range, high output with short rise-time, and calibrated pulse width and frequency controls. A monostable adjustable-width multivibrator is triggered by internal free-running multivibrator or by external pulses. Limiter and driver amplifier shape pulse delivered to output polarity-reversing amplifier. Input and output trigger pulses are fed through isolation amplifiers.—*Measurement Div., Mc-Graw-Edison, Boonton, N. J.*

For more information circle **253** on inquiry card.

HIGH-VOLTAGE TEST SETS

New K Series insulation testers, available in voltage ranges of 5 to 150 kv and in capacities from ½ to 100 kva, feature high power capacity, low wave-form distortion, metering directly at HV output, trip-free circuit

For ALL your dry battery needs

BURGESS

Serves You Better!

MOST COMPLETE LINE OF STANDARD BATTERIES

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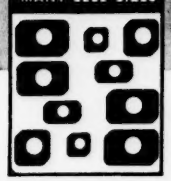
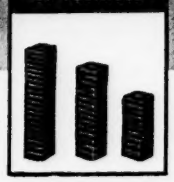
FREE DESIGN SERVICE FOR NEW APPLICATIONS

For those special applications, skilled Burgess Engineers offer you a FREE design consultation service. When your particular problem has been solved, Burgess will manufacture the exact battery to fit your needs, regardless of quantity required!

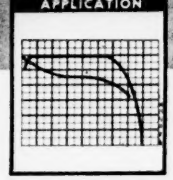
CHOOSE FROM MANY CELL SIZES



UNLIMITED RANGE OF VOLTAGES



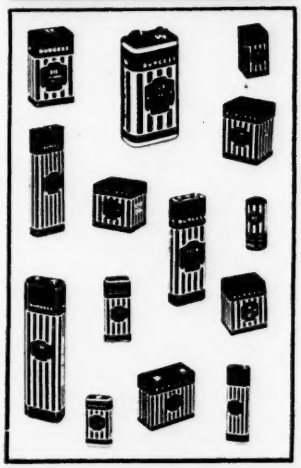
CAPACITY TAILORED TO YOUR APPLICATION



BURGESS *Exclusive WAFER CELL CONSTRUCTION Gives Greatest Selection of Dry Batteries*

The revolutionary Wafer Cell offers a 30% increase in battery life at no increase in size. This exclusive Burgess construction consists of a sandwich of manganese dioxide mix between two flat electrodes of zinc and carbon with spots of hot silver wax applied to each exposed pole of the cell, allowing perfect electrical contacts throughout and almost complete absence of vibration. Cells are wrapped in Mylar film and packed in such modern materials as aluminum for compactness, long shelf life, exceptional service life, outstanding dependability.

HUNDREDS OF TYPES AVAILABLE



TRANSISTOR ACTIVATORS

Burgess Activator Batteries for transistor circuits are smaller and more compact in size. Yet they deliver 30% more power because of the patented "wafer-cell" construction. Burgess Activators give you compact power, uniform performance, longer shelf life . . . . . all combined with modern packaging.

RESERVE BATTERIES

Can be stored dry for years. Activated only when immersed in water. No handling of dangerous electrolyte, no spilling or leaking! Wider range of efficient operating temperatures than any other type of battery.

Send for Engineering Data on Dry Batteries and Free Specifications Check Chart

BURGESS BATTERY COMPANY

FREEPORT, ILLINOIS

For more information circle **83** on inquiry card.

INSTRUMENT ENGINEERS . . .

here's a money-saving tip on small valves

You can stop worrying about heavy-handed operators ruining the stem points and seats on your small valves when you install Hoke's new 270 Series bar stock valves with plastic pointed stems. Let them "tighten down" all they want, because these long-wearing nylon or corrosion-resistant Kel-F tips have taken 700 cycles of operation at 3500 psi using twice the normal closing force—and the valve did not leak across the seat. They'll save you money three ways—cutting valve replacement, down-time and maintenance.

Use this new Hoke valve for vapor or vacuum leak-tight closure, in service up to 5000 psi. It also minimizes opening pressure surges, and meets applicable MIL specs for use on high pressure compressors. Available in ⅛" or ¼" sizes, globe or angle pattern, with O-ring or Teflon packing. All valves can be panel-mounted.

Complete information is yours on request. Write us today.

Why buy big when you can buy small

HOKE

HOKE INCORPORATED
FLUID CONTROL SPECIALISTS
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For more information circle **84** on inquiry card.

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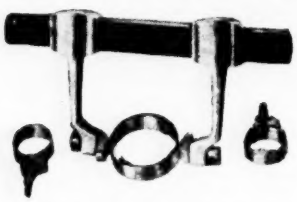
Dept. IN-8—223 W. Madison, Chicago 6, Ill.
Dept. IN-8—4747 Century, Inglewood, Calif.

For more information circle **85** on inquiry card.

THE ROLYN
(Snake) Plier

An indispensable tool for assembly and dismantling of optical, radio, scientific instruments and all kinds of mechanical equipment.



The SNAKE PLIER consists of two coil springs with their turns interleaved, attached to two arms projecting from and sliding for adjustment of diameter on the main supporting bar. Two sets of springs are supplied and additional sizes are available.

Ideal for use in all fields where a positive friction grip is required in loosening, or tightening, of the most delicate and fragile threads, or thin wall tubing without danger of damaging, or of marking. Can be used on right or left hand threads. It is equally effective at any angle.

Exhaustive tests in Government workshops and research depts. have proved the efficiency of the Rolyn SNAKE PLIER.

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For more information circle **86** on inquiry card.

NEW INSTRUMENTS

breaker, dual-scale KVM with means to readily recalibrate ranges by screw-driver-adjustable control, plus usual switches, continuously-adjustable output control with zero-start interlock, etc.—*Peschel Electronics, Inc., Towners, Patterson, N. Y.*

For more information circle **254** on inquiry card.

TINY INDICATOR

New Model HCM 7/16 miniature core-magnet moving-coil indicator is small enough to fit within other indicating instruments to signal position, malfunction, etc.; is hermetically-sealed; withstands extreme vibration; is available with either flag or pointer display in a wide variety of electrical sensitivities and functions.—*Marion Electrical Instrument Co., Grenier Field, Manchester, N. H.*

For more information circle **255** on inquiry card.

RMS MILLIVOLTMETER

New MV-32A high-precision ac vacuum-tube voltmeter uses an electronically-protected vacuum thermocouple as its rms-responsive meter-rectifier. Measurements are made by comparing unknown voltage with a 0.1% accurate 1000-cps signal and adjusting calibrator-attenuator until unknown voltage and calibrator signal produce identical pointer deflections. Five transfer points are available for this comparison to accommodate signal wave-forms having maximum permissible crest factors between 2 and 10. Accuracy within basic frequency range (50 cps to 5 kc) is better than 0.5%, at other frequencies 2%. Total frequency range 10 cps to 500 kc; total voltage range 300 uv to 1 kv.—*Millivac Instruments, Div. of Cohu Electronics, Inc., 2315 Second Ave., Carman, Schenectady 3, N. Y.*

For more information circle **256** on inquiry card.

THERMOCOUPLE LEADWIRE ADAPTER

New adapter is designed for permanent leadwire connections on MgO or alumina-insulated high-temperature sheathed thermocouple conductors. Accommodates sheath diameters of 0.040", 0.062", 0.125", and 0.187". Cold junction may be potted with epoxy resin or high-temperature cements.—*Thermo-Couple Products Co., Inc., 729 North Addison Ave., Villa Park, Ill.*

For more information circle **257** on inquiry card.

MERCURY SWITCH

New mercury switch, capable of handling 100-amp current at 115 v (70 amps at 230 v) is fully compensated to accommodate large in-rush overload. High current carrying capacity makes possible use in applications for which mercury switches have been considered unsuitable, such as direct control of motors and generators. Jena glass and other hard glasses are used for body and wells. A ceramic shield is fused solidly to the glass body to provide protection against make-break sparking.—*American Designed Components, Inc., Jericho, L. I., N. Y.*

For more information circle **258** on inquiry card.

OSCILLOSCOPES

New Basic Panelscope Model P-1 comprises maker's Rayonic 3SP1 CRT with usable screen area of 1¼" x 3", high-voltage power supply, CRT escutcheon with positioning, beam and focus controls and variable edge-lighted graph screen with ambient light filter. ★New Indicator Panelscope Model P-100 comprises Basic unit plus a selenium rectifier type low-voltage power supply for positioning and second-anode adjustment only: spot can thus be positioned. Circuit is designed for horizontal, vertical and intensity connections.—*Waterman Products Co., Inc., 2445 Emerald St., Philadelphia 25, Pa.*

For more information circle **259** on inquiry card.

SIX-CHANNEL OSCILLOGRAPH

New space-saving packaging method is used for 6-channel Series 150 direct-writing oscillographic recording systems: a single vertical mobile cabinet contains Model 156-5466 Basic Assembly, comprising six driver amplifier-power supply units and 6-channel recorder assembly. To complete system, user adds any of 12 optional interchangeable plug-in Series 150 preamplifiers.—*Sanborn Co., Industrial Div., 175 Wyman St., Waltham, Mass.*

For more information circle **260** on inquiry card.

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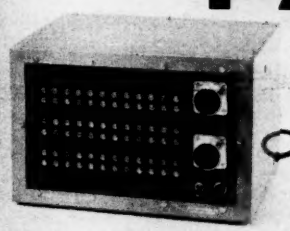
Alnor

For more information circle **87** on inquiry card.

PACE



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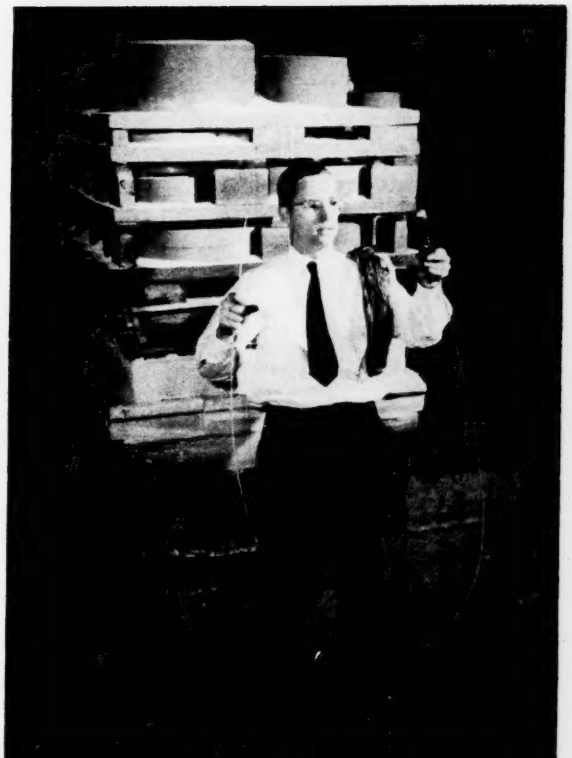
For more information circle **88** on inquiry card.



Here's a thermocouple for hard-to-make measurements

BRISTOL "Armorox" thermocouple, here about to be installed in tunnel kiln truck, is more flexible and smaller, but more rugged, than conventional thermocouples.

The Bristol "Armorox" thermocouple now makes difficult temperature measurements easy.

Good for temperatures up to 2000°F. and at pressures to 50,000 psi, the "Armorox" thermocouple is metal-sheathed, ceramic-insulated and *flexible*—easily bent around twice its own diameter to get into out-of-the-way places. What's more, no additional protecting tube is required.

The entire line of Bristol pencil-type thermocouples is offered in "Armorox" metal-sheathed ceramic-insulated construction as well as conventional construction. *Metal-sheathed construction plus tightly packed refractory insulation now permits use of smaller gauge wire than ever before at higher temperatures.* Wire sizes as small as #30 AWG give outstanding service in the advanced construction.

Sheathing available in stainless steel and Inconel*—other metals available for special applications. Diameters from 1/16 to 1/4 inch. Lengths up to 30 ft. Thermocouples available in Chromel-Alumel†, iron-constantan, copper-constantan, and other materials. Can be used for every application of conventional pencil-type thermocouples. Meet the ISA standards for accuracy.

Write for complete data on this Bristol development in pyrometry. The Bristol Company, 154 Bristol Road, Waterbury 20, Conn. B-15

*T. M. Reg. by International Nickel Co.
†T. M. Reg. by Hoskins Manufacturing Co.

BRISTOL *TRAIL-BLAZERS IN PROCESS AUTOMATION*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **89** on inquiry card.

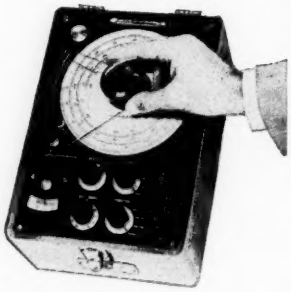
SEE THEM AT THE ISA SHOW (BOOTH 858)

5 new portable instruments for precise pyrometric and electrical measurement

THE PYROTEST

Checks recorders, controllers, thermocouples, potentiometers, millivoltmeters. 19 different scales, interchangeable in seconds. o F. or o C. calibrations for all thermocouples. Scales read directly temperatures (32° F. to 3215° F.) or millivolts (0 to 155). Cold junction compensation.

Size: 12¼" x 9" x 8½" Weight: 12 lbs.



THE THERMOTEST

An all-purpose testing instrument for precise measurement of temperatures from −200° F. to +600° F. and emf's to 20.1 millivolts. Only portable potentiometer with interchangeable direct reading scales and automatic compensation. Scales interchangeable in seconds for use with three types of thermocouples.

Size: 12¼" x 9" x 8½" Weight: 14 lbs.

MV-1 POTENTIOMETER

For testing, calibrating or servicing newest process controllers and amplifiers which convert millivolt input signals into proportional currents for control or telemetering. Combines all functions of precision potentiometer, millivolt source and milliammeter. 1/10 of 1% accuracy.

Size: 5⅜" x 8" x 5⁹⁄₁₆" Weight: 5½ lbs.

THE AUTOCOMP I

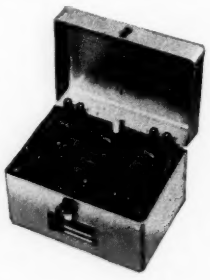
For instrument checking and thermocouple measuring. Gives automatic cold junction compensation to devices used for measuring or controlling with thermocouples. Exclusive circuit employs thermistor network to match non-linear characteristics of thermocouples with output characteristics of bridge.

Size: 5⅜" x 8" x 5⁹⁄₁₆" Weight: 6 lbs.

RU-1 "RUN UP" SOURCE

Combination millivolt and milliampere "run up" source for instrument calibration. Checks newest process controllers and amplifiers. Current source furnished by two self-contained 90V batteries made to give stable, uniform outputs with cold cathode type voltage regulator tube. Self-contained.

Size: 5⅜" x 8" x 5⁹⁄₁₆" Weight: 10 lbs.



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For more information circle **90** on inquiry card.

NEW INSTRUMENTS

MINIATURE MICROSYN

New T-813 Miniature (¾") Microsyn, originally designed for use in Series 10 pendulum and gyro units,

is applicable to position-indication of gyros, process control, control follow-up devices, motion and torque amplification.—*Sterling Precision Corp., Instrument Div., 17 Matinecock Ave., Port Washington, L. I., N. Y.*

For more information circle **261** on inquiry card.

DIRECT-VIEW STORAGE TUBES

New DVST's in 5", 10", 15" and 21" screen sizes, combine black-background screen and storage features

for utmost usefulness in military, industrial, and lab equipment which require long retention of electrical transients and half-tones, and viewing in open areas or brightly-lighted enclosures. Photo shows a 15" DVST which retained a half-tone radar image for more than five minutes. —*Allen B. Du Mont Labs., Inc., 750 Bloomfield Ave., Clifton, N. J.*

For more information circle **262** on inquiry card.

HI-TEMP CONVERTER

New high-temperature dc-to-dc converter features advanced circuitry using latest silicon power transistor enabling operation to 120°C (248°F); input available from 12 to 30 v; output available from 6 to 300 v; regulation line and load 1%, temperature line and load 5%. Shock, vibration, etc., per MIL specs for missile application.—*Jordan Electronics, 3025 W. Mission Rd., Alhambra, Calif.*

For more information circle **263** on inquiry card.

TRANSISTORIZED SUPPLIES

Three new transistorized power supplies: (1) New rack-mounted Model TPS-1 with voltmeter and ammeter is designed to replace lab storage batteries: 100-130-vac input, output 10-14.5 vdc @ up to 15 amp, regulated within 0.2% over full input voltage and output current ranges; ripple 2 mv rms max at full load; recovery time better than 1 ms; either positive or negative side of output can be grounded; internal impedance < 0.003 ohm. High-volume blower forces air across heat sink area. (2&3) New TPC-7 and TPC-8, contained in heat-dissipating aluminum cases, can be furnished for any desired output between 1 and 25 vdc with loads up to 350 ma. Under normal lab operation, output voltage of TPC-7 varies less than 0.03% during line voltage or output current fluctuations, making it in effect a standard cell capable of supplying useful power. Regulation of TPC-8 is 1% for line and load. This supply is designed for subassembly or chassis mounting and its life expectancy is over 50,000 hr without maintenance.—*Southwestern Industrial Electronics Co., 2831 Post Oak Rd., Houston 19, Texas.*

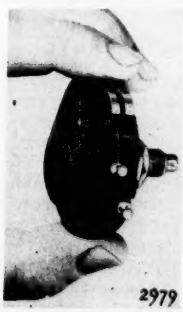
For more information circle **264** on inquiry card.

RESISTOR FOR PRINTED CIRCUITS

New Type PC-5 low-operating-temperature 5-watt resistor features a high degree of automatic assembly, is particularly recommended for printed-circuit board mounting in circuits requiring a wire-wound resistor with an actual wattage dissipation of 5 watts or less, and for any circuit requiring a wire-wound resistor capable of 7 watts continuous operation. Its element-lead assembly is sealed in a rectangular ceramic case with special IRC cement.—*International Resistance Co., Boone Plant, Box 393 Boone, N. C.*

For more information circle **265** on inquiry card.

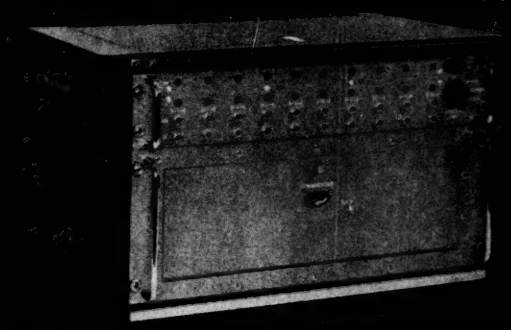
LOW-RESISTANCE RHEOSTAT



New Series 310 Mikrohm rheostats feature infinitely fine adjustment: non-coil-stepless design for exact linear resistance variation; are available in resistance ranges of 0.25 to 3.0 ohms with maximum current ratings of 0.25 to 1.0 amp. Minimum insertion resistance is about 10% of rheostat's maximum resistance.—*The Superior Electric Co., Dept. M310, Bristol, Conn.*

For more information circle **266** on inquiry card.

30,000 samples per second *



* *300 samples per second for each of 100 inputs*

Wherever a large number of transducer signals must be sampled for high-speed recording, the Wiancko High-Speed Commutator can give unrivalled performance. It will accept up to 100 low-level ac or dc inputs and sample at up to 30,000 samples per second. It will maintain this pace over trillions of faithful cycles of operation because it uses solid-state elements exclusively, requiring only 8 watts of power.

The High-Speed Commutator is adaptable to a great variety of FM telemetering systems, AM systems, logging systems, and dc data systems. The commutated output is directly applicable to any high-speed analog-to-digital converter. The commutator's clock-pulse generator can be used to synchronize the converter with the commutator. In many applications no amplifiers are needed since inputs as low as ±50 millivolts full scale can be commutated directly.

For more detailed information, write for Product Bulletin 103.

Wiancko Engineering Company
255 N. Halstead Avenue • Pasadena, California

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For more information circle **91** on inquiry card.

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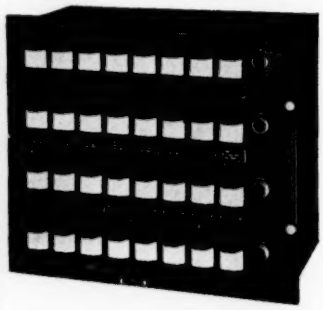

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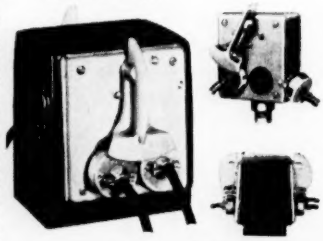

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For hazardous and explosive areas . . . and all general purpose applications.

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For hazardous and corrosive atmospheres and all general purpose applications.

MOTOR DRIVEN FLASHERS

with mercury switch interrupters

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4332 North Western Avenue
Chicago 18, Illinois

For more information circle **93** on inquiry card.

NEW INSTRUMENTS

TRIGONOMETRIC VDR's

New Model PT315 trigonometric voltage-dividing resistors, usable at dc and carrier frequencies, are internally compensated for a specific load so that no isolation amplifier is required. They are 15-turn units embodying sine or cosine function over a 100° range of function. Conformity is 0.02% for sin θ or cos $\theta < 0.707$ and 0.04% for sin θ or cos $\theta > 0.707$. All materials are fungus-proof and hi-temp resistant. Teflon seals minimize dust and moisture.—*Analogue Controls Inc., 39 Roselle St., Mineola, N. Y.*

For more information circle **267** on inquiry card.

C-V TRANSFORMERS

Two new constant-voltage transformers in 2-kva and 3-kva capacities feature significant reductions in size and weight; offer new variations in circuit connections; have new output arrangement permitting 3-wire 118/236-v loading. Load can be distributed among any or all three outputs if transformer's total rating is not exceeded. Any three stock units of the same rating can be connected in delta to 3-phase power sources; single-phase outputs can be connected either grounded-neutral wye, or to isolated single-phase loads.—*Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill.*

For more information circle **268** on inquiry card.

VARIABLE TOROIDS

New ATE-11 and ATE-12 subminiature encapsulated variable toroids, equivalent in electrical specs to maker's AT-11 and AT-12 Adjustoroids, weigh about ½ oz; have no physical contact between adjusting screw and toroid itself; and stepless adjustment of inductance over a 10% range.—*Burnell & Co., Inc., 10 Pelham Parkway, Pelham Manor, N. Y.*

For more information circle **269** on inquiry card.

HF GERMANIUM TRANSISTOR

New 2N623 high-frequency *p-n-p* diffused-base germanium transistor enables manufacturers to realize high gain at high frequencies ideal for TV IF's, radio RF's, and VHF oscillators. In a JETEC TO-05 outline package it is especially well suited for use in ultrahigh-speed non-saturated computer applications because of its 0.025-usec switching time. It has 200-Mc typical maximum frequency oscillation and 90-Mc typical alpha cutoff frequency; 50 db gain at 1 Mc and 13 db gain at 50 Mc. Breakdown voltage −30 v and 40 mw total dissipation at 25°C.—*Texas Instruments, Inc., P. O. Box 312, Dallas, Texas.*

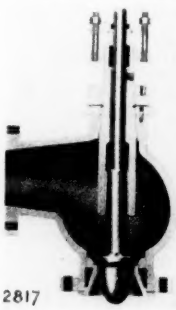
For more information circle **270** on inquiry card.

CUSTOM BELLOWS

New welded metal bellows are custom-engineered in various sizes and special metals to provide extreme accuracy and long life over a wide range of critical operating conditions.—*Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co., 155 Hill St., Milford, Conn.*

For more information circle **271** on inquiry card.

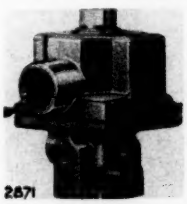
HIGH PRESSURE VALVES



New standard S Line control valves available in sizes from 1" to 14", with pressure ratings up to 2500 lb ASA, incorporate a number of features not found in conventional control valves: streamlined-contour body of extra-heavy construction; self-sealing bonnet; oversized stem and stem guide; Venturi seat ring and parabolic plug assuring tight shut-off etc. In smaller sizes, new valves are equipped with Cylinder Conomotor; in larger sizes with Rotomotor.—*Conoflow Corp., 2100 Arch St., Philadelphia 3, Pa.*

For more information circle **272** on inquiry card.

3-WAY SOLENOID VALVE



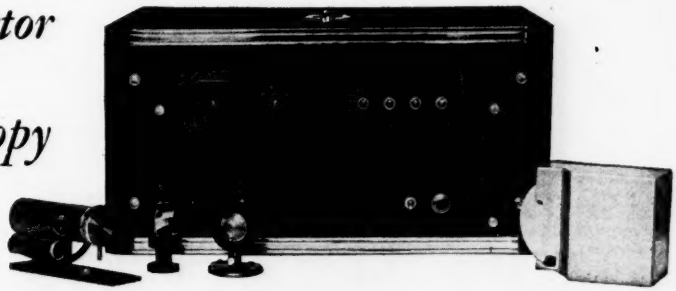
New A Series valves for use with medium-size cylinders bridge gap between V5 line used with small cylinders and M3 line for large cylinders. First of A Series line is a 3-way n-c valve with 5/32" orifice and ¼" NPT ports, pressure rating 125 psi, for use with oil, air and inert gases.—*Skinner Electric Valve Div., 105 Edgewood Ave., New Britain, Conn.*

For more information circle **273** on inquiry card.

A Superior Detector

for

Infra-Red Spectroscopy



GOLAY PNEUMATIC DETECTOR

Among the characteristics that render the Golay Detector superior to other types of detectors for use in infrared spectroscopy are:

1. **An effective sensitive area 3/32" in diameter.**
2. **Sensitivity of 6 x 10^{-11} watts RMSENI when used with "chopped beam" method and with recording time constant of 1.6 second.**
3. **Uniform sensitivity from the ultra-violet through the visible and the entire infra-red, and up to the micro-wave region.**
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For more information circle **94** on inquiry card.

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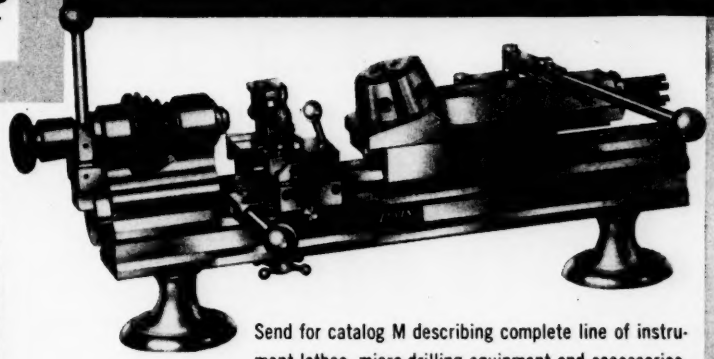
LEVIN TURRET LATHES

PRODUCE SMALL INSTRUMENT PARTS BETTER



A small precision turret lathe for second operations and production of instrument parts. Available in two collet capacities, 5/16" or 3/16". The 6 position turret is self indexing and has hardened ways. Turret holes are 1/2" diameter. Turret travel 1-5/8". The cross slide has a swivel side at one end and a rigid tool block at the other. Lever collet closer provides quick opening and closing. A variety of turret tools with 1/2" shanks is available.

Send for catalog M describing complete line of instrument lathes, micro-drilling equipment and accessories.

Louis Levin & Son, Inc., 3610 S. Broadway, Los Angeles 7, California

For more information circle **95** on inquiry card.

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For more information circle **97** on inquiry card.

Automatic Control Technology, Modern Theory and their Usefulness

483 + XV pages, 1957, 898 illustrations and 48 tables. Includes 90 advanced papers on control technology, as delivered in original language (English, French, German, Russian; all Russian papers are translated into German; about ½ of book is in English). 9" x 12". Handsome cloth binding. Printed by R. Oldenbourg Verlag, Munich, Germany.

The book is a report of the Heidelberg Meeting, September 25 to 29, 1956, arranged by the VDI/VDE-Fachgruppe Regelungstechnik with the cooperation of the Fachausschuss Regelungsmathematik der Gesellschaft fuer angewandte Mathematik and Mechanik (GAMM); edited by Gerd Mueller, for VDI/VDE-Fachgruppe Regelungstechnik.

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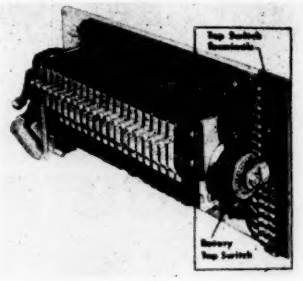
NEW INSTRUMENTS

HEAVY-DUTY STEP SWITCHES

New MT Series have optional feature of rotary tap switch for use with indicator circuits and/or for interlock sequence control; are available with 2 to 20 independent 10-amp circuits; are driven by a rotary ac solenoid at speeds up to 300 steps per minute. Up to 16 steps per cycle available with each circuit closed for one or more steps depending on cam breakouts.—*Eagle Signal Corp., Moline, Ill.*



For more information circle **274** on inquiry card.

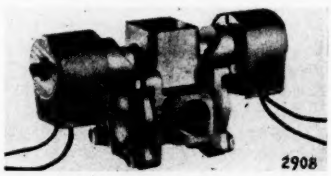
MINIATURE SPEEDLIGHT

New Rectablitz, said to be the world's smallest electronic speedlight, can be supplied with a special direct-contact shoe for use with Minox cameras without a synchronization cord. Accessory clamp attaches standard reflector to case of any twin-lens reflex camera.—*Karl Heitz, Inc., 480 Lexington Ave., New York 17, N. Y.*

For more information circle **275** on inquiry card.

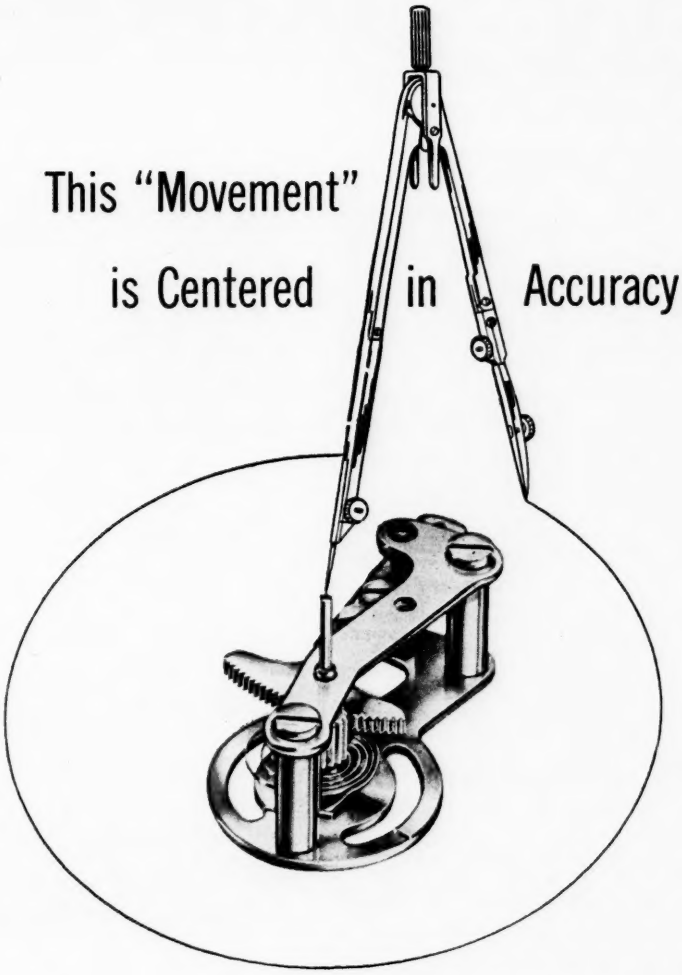
DUAL SOLENOID INLET VALVE

New Bulletin 8350 dual solenoid inlet valve, principally intended for controlling hot and cold water, has a heavy forged brass body and bonnet, Buna N diaphragms; n-c operation; dual solenoids energized together or separately as required; pressure range 5 to 125 psi; available at most standard voltages.—*Automatic Switch Co., Florham Park, N. J.*



For more information circle **276** on inquiry card.

This "Movement" is Centered in Accuracy



The rotary movement in Ashcroft Duragauges has a geared center shaft on which the pointer is mounted. When pressure flexes the Bourdon tube, the pointer is always positively positioned. You can rely on the Duragauge for precise accuracy in measuring pressure no matter how severe the conditions of service.

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You can order Ashcroft Duragauges with all-stainless-steel movement or stainless steel with nylon bearings and pinion gear. A complete choice of Bourdon tube materials, pressure ranges, dial sizes and case designs and materials is available. Your industrial supply distributor will gladly help you select the best combination for your requirements. So, be certain of highest sustained accuracy, durability and economy – specify Ashcroft Duragauges.

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For more information circle **98** on inquiry card.

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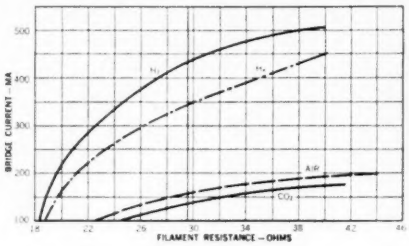

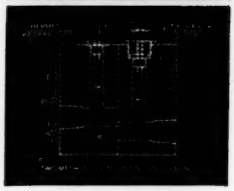

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For more information circle **99** on inquiry card.

Operation and Care of Circular-Scale Instruments

by James Spencer. Includes "trouble" charts for d-c, and for a-c instruments; covers d-c instruments, a-c ammeters and voltmeters, wattmeters, frequency meters, power factor meters and synchroscopes. Clothbound, 90 pages, 1949. $1.50

Control Valves

by C. H. Beard. New "one-book" reference on control valves . . . covers flow characteristics; mechanical features; valve capacity; sizing; body types; positioners; actuators, including d-c, electrohydraulic and gas hydraulic actuators. Numerous tables and illustrations. Paperbound, 236 pages, 1957, $2.00

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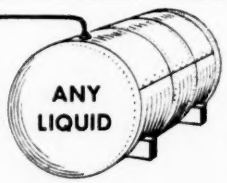

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For more information circle **100** on inquiry card.

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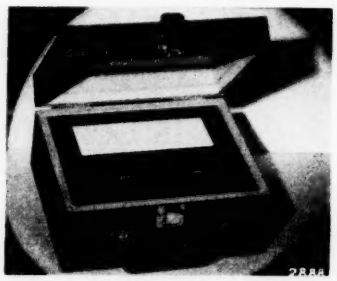
New instrument cases are made to customer's spec of strong crack-resistant Melamine in attractive wood

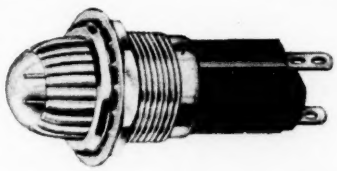


grains and other patterns. Mounting brackets or holes for instrument panels, handles, hinges catches, plastic bumpers, etc. No molds or die costs. Priced competitively with wood or metal. Short production runs invited.—*Warwick Products Co.*, 1575 *Riverbed Rd., Cleveland 13, Ohio.*

For more information circle **277** on inquiry card.

BRIGHT PILOT LIGHT

New pilot light (shown actual size) uses new high-brightness neon glow lamp NE-51H; has built-in resistor



completely insulated in molded Bakelite and sealed in metal (exclusive Dialco feature). Available in two sizes, for mounting in $\frac{13}{64}$" or $\frac{9}{16}$" dia panel clearance holes. Wide selection of plastic lenses; five lens colors; screw, soldering, or quick-connect terminals.—*Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y.*

For more information circle **278** on inquiry card.

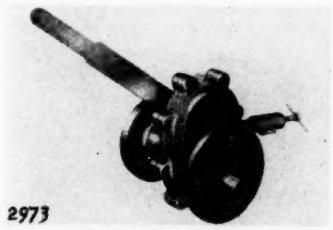
H-C H-V RECTIFIERS

New complete series of hermetically-sealed high-current silicon cartridge-type rectifiers feature current ratings three to four times those of standard high-voltage units; are designed for forced-air or liquid cooling; have metallized ceramic housings with ferrule-type terminals for insertion into standard 30-amp fuse clips. Available in PIV ratings of 1500 to 16,000 @ 210 to 360 ma dc output currents. (For short durations, load currents can amount to several times rated values.)—*International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.*

For more information circle **279** on inquiry card.

GATE VALVE

New unique-design Lubeseal valve provides tight shut-off of flow pressures as high as 500 psi. Gate or disc



is swung into closed position by hand lever, then a plastic lubricant is forced down through channels by hand screw. This lubricant's pressure against periphery of gate and its seat holds faces of gate tight against body. To open valve, cock on lubricator is opened and screw is backed off to relieve lubricant pressure.—*W. S. Rockwell Co., 200 Elliot St., Fairfield, Conn.*

For more information circle **280** on inquiry card.

MILLIVOLT SOURCE

New portable millivolt source for calibrating recorders, etc., has two ranges of 0-10 and 0-100 mv; calibrated dial readable to three places; accuracy 0.25%.—*Westronics, Inc., Industrial Div., 3605 McCart St., Fort Worth, Texas.*

For more information circle **281** on inquiry card.

FREQUENCY INDICATOR

New Model FR 305 provides direct indication of flow rate, frequency, or rpm; combines maker's transistor-

ized frequency-to-voltage converter with a high-grade voltmeter calibrated in desired units (choice of 90° or 250° movement, etc.)—*Waugh Engineering Co., 7842 Burnet Ave., Van Nuys, Calif.*

For more information circle **282** on inquiry card.

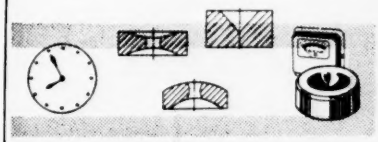
PRECISION

defined by the dictionary

. . . . "the quality or state of being precise; accuracy; mechanical exactness."

defined by an instrument maker . . .

Swiss American



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For more information circle **101** on inquiry card.

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For more information circle **102** on inquiry card.

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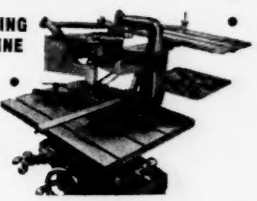

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For more information circle **103** on inquiry card.

POST DECITRON ELECTRONIC PRODUCTS

Electronic Counter with in-line Nixie Tube Read-Out

Model PR-2

Remote, visual reading of production line counts is made easier with Post's new combination . . . a Decitron Electronic Counter with an in-line Nixie Tube Read-Out.

Specific Decitron Counters for nearly any type of counting problem can be furnished. The "Nixie" continuously displays in lighted, numerical figures, the count being accumulated on the associated counter. Mounting may be done as one unit, or with Nixie remotely located. Preset, or "batch" counting also possible. Specific proposals, on request.

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For more information circle **104** on inquiry card.

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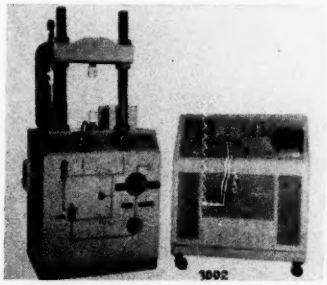
For more information circle **106** on inquiry card.

NEW INSTRUMENTS

HIGH-RATE TESTER

New Model 625B features essentially constant deformation rates (continuously variable from 4 to 8000

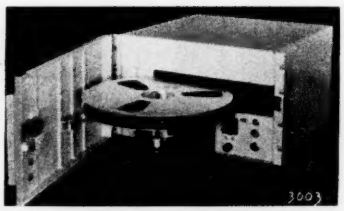


ipm) to permit precisely determining properties at heretofore unavailable rates of loading; yields a photographic record of stress, strain, and time.—*Allegany Instrument Co., Inc.*, 1091 *Wills Mountain, Cumberland, Md.*

For more information circle **283** on inquiry card.

DEGAUSSER

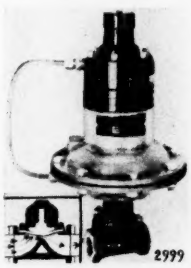
New automatic bulk tape eraser accommodates all types of 7" to 14" metal and plastic reels in tape widths



up to 1"; takes NARTB reels, also business-machine and special-type reels by using a spindle adapter. Operation: reel is placed on spindle and door is closed. Moments later, green light signals completion of automatic degaussing cycle.—*Ampex Corp.*, 934 *Charter St., Redwood City, Calif.*

For more information circle **284** on inquiry card.

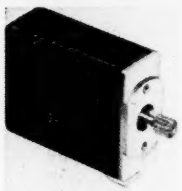
SLUDGE CONTROL VALVE



New Type 900 air-operated diaphragm-type valve provides precise control of small flows of slurries, sludges, pulps and acids to 150 psi and 400°F; has extremely low C_v and better than 50/1 useful rangeability; is available in direct or reverse-acting models, and in a wide range of body and diaphragm materials.—*Uniflow Valve Corp., Cranford, N. J.*

For more information circle **285** on inquiry card.

RECTANGULAR P-M MOTOR



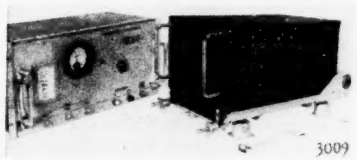
3008

New permanent-magnet motor, designed to MIL-M-8609, features maker's symmetrical armature winding, simple construction, good heat dissipation, precision double-shielded bearings and Alnico magnets. A typical 27-vdc motor is rated 0.013 hp continuous duty at 10,300 rpm and 0.8 amp. Ambient temperature range −65°F to 200°F.—*Barber-Colman Co., Rockford, Ill.*

For more information circle **286** on inquiry card.

FREQUENCY STANDARDS

New Stationary Frequency Standard (left) withstands extremes of temperature, humidity, vibration and



3009

shock; features two-stage oven giving unusually high circuit stability of better than one part in 10^9 for a 24-hr period; produces frequencies of 1 Mc and 100 kc at 1 v rms across a 50-ohm load. Frequency adjustment covers a range of ± 5 parts in 10^8 readable to one part in 10^{10}. ★New mobile frequency standard is sufficiently rugged for airborne and vehicular use; features stability to one part in a billion maintained by two-stage oven; withstands extremes of temperature, humidity, vibration and shock inherent in mobile environments.—*Borg Equipment Div., George Borg. Corp., 120 S. Main St., Janesville, Wis.*

For more information circle **287** on inquiry card.

DISPLACEMENT PICKUPS

New subminiature Model 141 Linipot, said to be the smallest unit of its type now available, operates with

3010

a high-level ac or dc output requiring no amplification for recording, control or telemetering. Five standard strokes from 3/16" to 7/16"; resolution from 0.0010" to 0.0030"; independent linearity 1.0%; five standard resistance values from 500 to 10,000 ohms. Optional models with

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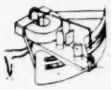
TEMPERATURE CONTROLLERS

serve your need Best



General characteristics: indicating *and* providing positive control; distinctively simple, convenient, reliable, economical; tubeless; plug-in meter units; thermocouple break protected; guaranteed; demonstrated and serviced from offices in many cities here and abroad.

See us at the 13th Annual ISA Instrument-Automation Conference & Exhibit—Philadelphia, Penn. Sept. 15-19 Booth # 1332

MODEL J SERIES

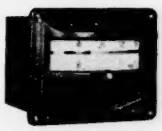
for **Off-On** control

MODEL JP SERIES

for **Proportioning** control; more precise where heating-cooling factors are more dynamic

MODEL JL SERIES

combines **High Limit** and **Off-on** control



MODEL JE SERIES

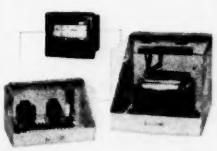
Portable—ideal for laboratories

MODEL JG SERIES

provides **Program** control, applying any of above control actions to control both time and temperature.

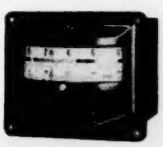
MODEL JS SERIES

gives **Step-less** control; **extremely precise**



MODEL JT SERIES

gives **3-Position** control for motorized valves, 3-phase heating, heating-cooling cycles



All controllers can be furnished for thermocouples or resistance bulbs. For data on these or other West instruments and accessories, use your classified phone directory or write direct.

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For more information circle **107** on inquiry card.

Waugh / MINIATURIZED FREQUENCY INSTRUMENTATION

These transistorized frequency-to-DC converters, developed for use with Waugh turbine flowmeters, are finding many additional applications in aircraft and missile telemetry, as well as ground support equipment. Their rugged and compact designs provide high accuracy and reliability . . . even under severe environmental conditions.

FREQUENCY-TO-VOLTAGE CONVERTER FR-300 SERIES

For precision flow rate or R.P.M. measurements. Combines compact size with high stability and precision. Fully transistorized.

- 3" x 2" x 2⅛" overall size.
- Input and output: 15 models; typical output 0-5 volts or 0-1 ma, input ranges from 10 cps to 5 kc
- Better than 0.002% per degree temperature coefficient.

FREQUENCY INDICATOR FR-305

Combines indicating meter with transistorized frequency-to-voltage converter in a single compact package. Also available for use with standard tach generators.

- Optional 115v ac or 28v dc power supply.
- Accurate to 1% of full scale.
- Custom scales for all flow ranges and measurement units.
- Aircraft type 250° scale instruments available.

NARROW-SPAN FREQUENCY TO VOLTAGE CONVERTER FR-303

Suppressed zero provides high accuracy output over narrow frequency range. Especially suited for monitoring AC power frequencies. Will provide 0-5 volts dc between 370 and 430 cps with 0.05% overall accuracy.

- Various frequency spans available.
- Excellent long term stability.
- Ideal for missileborne telemetry.

Send for newly revised Bulletin 103, giving complete data on these products.

Waugh ENGINEERING CO. 7842 Burnet Ave., Van Nuys, California

Sales representatives in principal cities

For more information circle **108** on inquiry card.

COMPRESSED AIR DRYERS AND CLEANERS

Van-Air DRYER

OPERATES FOR LESS THAN 2 CENTS PER 12,000 CUBIC FEET

VAN-AIR DRYERS purify raw compressor air — extract water up to 1.07 lbs. per 1000 cu. ft. — reduce moisture to ZERO-dewpoint — remove contaminating bacteria, scale, etc. — deliver air uniformly clean and dry.

VAN-AIR DRYERS have no elements to heat, regenerate or regulate — average ten minutes care per month — process air automatically with a non-corrosive desiccant (see diagram) — operate with less than 1% pressure drop.

Many plants, shops and labs use the VAN-AIR to protect instruments, testers, circuits, etc. Others use it to prevent fouling of chemicals, compounds, plastics, foods, drugs, etc. Some need it to reduce spoilage in product finishing, spraying, blasting, packaging, assembling, etc. Capacities range up to 8000 scfm, 6000 psig.

See it in action, Van Products Booth, Instrument-Automation Exhibit, Convention Hall, Philadelphia, Sept. 15-19. Send NOW for brochure.

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For more information circle **109** on inquiry card.

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of Cables, Wiring, Motors, Transformers, Capacitors, Appliances

Yours . . . for better maintenance and production testing.

ALL PURPOSE TESTER

Direct reading megohms, ohms and voltage scales. Self-powered, accurate, no leveling or cranking. Write for your copy of this practical manual.

VIBROTEST®

Model 201 . . . Measures to 200 megohms at 500V-DC test potential, also 2000 ohm scale. AC and DC volts ranges 0-150/300/600. Only $136.50. Send for bulletin listing all VIBRO-TEST models.

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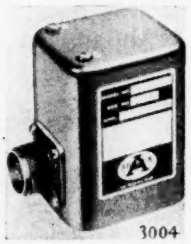
For more information circle **110** on inquiry card.

NEW INSTRUMENTS

infinite resolution available. ★New Model 158 fits inside a hydraulic actuator; is noise-free at 25-*G* vibration levels; is sealed and highly resistant to hydraulic fluids. Independent linearity 0.3% (0.5% for <1" travels). Standard strokes 1", 2", 3" and 4", with body lengths 3", 4", 5" and 6". Available with single or dual pot outputs in resistance ranges of 1, 2, 5, 10 and 20 kilohms.—*Bourns Labs., Inc., P. O. Box* 2112, *Riverside, Calif.*

For more information circle **288** on inquiry card.

TEMPERATURE MEASUREMENT SUBSYSTEMS

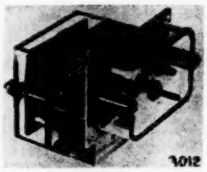


3004

New transistorized high-sensitivity TME-1SD (single-channel) and TME-2SD (dual-channel) are for use with fast-response 100-ohm thermometric probes to produce 5-v output for a 75-F° span. Each comprises a regulated power supply, transistor amplifier, and resistance bridge and associated zero and gain controls. Bridge can be balanced for zero setting between —320°F and 250°F. Gain adjustment allows full-scale span to be varied.—*Arnoux Corp.*, 11924 *W. Washington Blvd., Los Angeles* 66, *Calif.*

For more information circle **289** on inquiry card.

BATTERY-OPERATED MOTOR



3012

New Model TR subfractional-watt instrument motor weighs 2-½ oz complete with reduction gear; is believed to be the first commercially-available dc motor which has neither brushes nor commutator. Its rotating assembly comprises an Alnico disc supported on a stainless steel shaft. Rotative flux is created by stationary field coils commutated by means of transistors. Output torques are of the order of 10 ounce-inches at 1 rpm.— *Brailsford & Co., Inc.*, 670 *Milton Rd., Rye, N. Y.*

For more information circle **290** on inquiry card.

SOLENOID VALVES

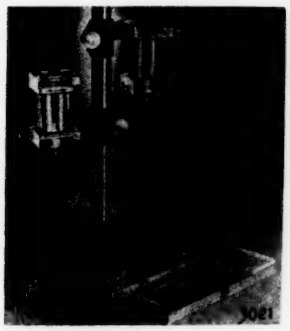
New solenoid valves feature absence of restrictions on orifice sizes—full 1/8" and 3/16" ports through all passages (2-35 cfm @ 0-200 psi); one-piece interval moving part; O-ring seals; sealed coil; life expectancy many millions of cycles (and, by inserting new seals, many millions

more); adjustable exhaust flow control and manual over-ride available. Valves can be bottom drilled for manifolding or tapped for standard connection (1/8 or ¼ NPT).—*Airmatic Valve, Inc., 7317 Associate Ave., Cleveland 9, Ohio.*

For more information circle **291** on inquiry card.

LOW-PRESSURE STANDARD

New No. 1425 hook gage for low air pressure and vacuum measurements (0" to 24") features perma-

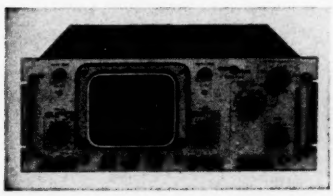


nent 0.001" accuracy; serves as a reliable standard against which other instruments can be checked or calibrated—especially those used in fan or blower testing.—*F. W. Dwyer Mfg. Co., P. O. Box 373, Michigan City, Ind.*

For more information circle **292** on inquiry card.

RACK-PANEL 'SCOPE

New K-11-R rack-mounted general-purpose oscilloscope features identi-



cal horizontal and vertical amplifiers of unusually high sensitivity and stability; new space-saving rectangular CRT; two amplifiers covering bandwidth from dc to 300 kc with sensitivity from 1 mv/cm to 150 v/cm; phase shift <3%; built-in calibrator and wide range of accurate sweep speeds.—*Electronic Tube Corp., 1200 E. Mermaid Lane, Philadelphia 18, Pa.*

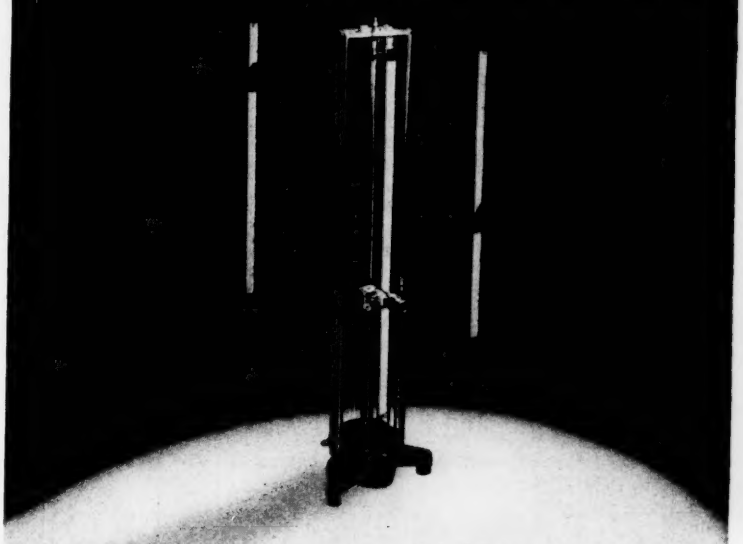
For more information circle **293** on inquiry card.

GAS ANALYZER

New Chroma-Cat for gas analysis combines chromatographic principle with a catalytic combustion cell detection unit; extends sensitivity of gas analysis, especially in hydrocarbon streams; is extremely sensitive to low concentrations of hydrogen; is designed for plant process use with par-

Something Special

IN A STANDARD STANDARD



For those jobs, only a manometer can do . . .

When you're faced with precision calibration, production checks of other accurate instruments, or any kind of laboratory pressure work . . . in fact, any time you need better than 0.1% accuracy that's the time to add a W&T precision mercurial manometer.

Rapid readout with the magnified magnetic vernier makes exact pressure readings easy. All 'round leveling, temperature compensation and gravity correction are included, of course.

range: 0 to 31.50 inches Hg., or any other desired pressure unit of equivalent range.

accuracy: 1/5000 over full scale.

For full information on all models of W & T precision mercurial manometers, write Dept. A-121.00.

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25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

W&T MERCHEN SCALE FEEDERS & METERS

for Automatic Batch Control
Continuous Blending
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Control the feeding of ingredients by weight to an accuracy of 1%.
Capacities range from 3 to 3000 lbs. per min.

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For more information circle **111** on inquiry card.

MINIATURE DIAPHRAGM VALVES

for the CONTROL OF LOW FLOWS

flows in CC's

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BOOTH 1166

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Philadelphia, Pa. Sept. 15-19.

Approx. 1/2 Size

The only specialists in the control of Low Flows

RESEARCH CONTROLS

P. O. BOX 5035 TULSA, OKLAHOMA

For more information circle **112** on inquiry card.

TACHOMETERS

TYPE "UO" UNIVERSAL CENTRIFUGAL TYPE

With Overspeed Protection

5 Ranges in each instrument
Cat. No. 303 30-12,000 RPM
Cat. No. 314 45-18,000 RPM
Cat. No. 322 60-24,000 RPM
Cat. No. 346 120-48,000 RPM

Bulletin 751

"JAQUET" SPEED INDICATORS (CHRONOMETRIC)

Guaranteed Accuracy within ½ of 1%

Cat. No. 2301 0-10,000 RPM
Cat. No. 2302 0- 1,000 RPM
Cat. No. 2304 0- 100 RPM
Suitable double rated speed. 3 models, various accessories.

Bulletin 735

STATIONARY TYPE MODEL "J"

Sizes, 3", 4", 5¼", 8", 10", and 20" dial diameter, flexible shaft driven.

Many standard ranges reading RPM, FPM, YPM, etc.

Bulletins 795, 796, 797

VIBRATING REED TACHOMETERS

Portable and Stationary Types. Measure speed by touch. Many different ranges from 900-100,000 RPM.

Bulletin 770

Booth #1522 ISA Phila.

HERMAN H. STICHT CO., INC.
27 PARK PLACE, NEW YORK 7, N.Y.

For more information circle **113** on inquiry card.

MEASUREMENTS' *New* VACUUM TUBE VOLTMETER

MODEL 162

This versatile instrument has been specially designed for voltage and resistance measurements in laboratories, on production lines and in service shops.

- **Push-buttons provide RANDOM ACCESS to all functions and ranges—reducing operator error and fatigue**
- **Balanced degenerative amplifier provides stable zero and good overload protection**
- **Single zero control for all ranges**
- **Compartment for lead and probe storage**

Laboratory Standards WRITE FOR BULLETIN

MEASUREMENTS
A McGraw-Edison Division
BOONTON, NEW JERSEY

For more information circle **114** on inquiry card.

NEW INSTRUMENTS

ticular application to hydrocarbon streams in chemical plants, petroleum and natural gas industries, and for streams involving partial combustion processes such as those found in coke ovens, heat-treating metals and ore reduction.—*Davis Instruments*, 47 *Halleck St., Newark* 4, *N. J.*

For more information circle **294** on inquiry card.

DECADE DELAY LINE

New lumped-constant decade delay line featuring high impedance output is available in 500, 1000 and 2000 ohms inputs. Variable from 0 to 11 usec in increments of 0.1 usec with risetime of 0.25 usec. Units are provided with coaxial input and output connectors. —*Epsco Components*, 108 *Cummington St., Boston, Mass.*

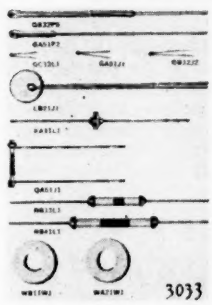
For more information circle **295** on inquiry card.

PRESSURE PICKUPS

Three new models: TP-201 is for differential ranges from 0-5 to 0-100 psid in a system up to 5000 psi; TPH-175 is a dynamically-balanced twin-spring Bourdon-tube type in ranges from 100 to 10,000 psia or psig; TPH-176 is similar to 175 but features heavy case for pressures up to 5000 psi for measuring from 100 to 5000 psid. All are available with linear or non-linear outputs with wire-wound or metal-film precision resistors. All will withstand 2000 cps at 25 G without damage.—*Fairchild Controls Corp.*, 225 *Park Ave., Hicksville, N. Y.*

For more information circle **296** on inquiry card.

THERMISTOR KIT



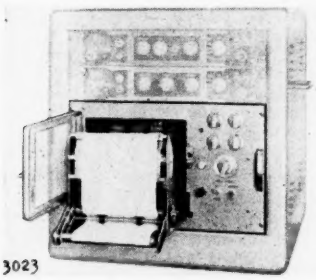
3033

New Model G200 Experimenter's Thermistor Kit comprises twelve representative thermistors, with complete curves and specifications for each; has been designed to assist engineers, and for experimental work. Each thermistor is separately packaged in its own "matchbook" cover and complete performance data are imprinted on each cover.—*Fenwal Electronics, Inc., Mellen St., Framingham, Mass.*

For more information circle **297** on inquiry card.

RACK-PANEL OSCILLOGRAPH

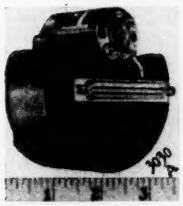
New Rectilinear Recorder, readily installed in any standard rack-panel cabinet, writes on true rectangular



coordinates; uses heated-stylus method with individual stylus heat control for each channel; is available with 2 to 6 recording channels; features flat frequency response to 70 cps. Pop-out sliding chart-drive unit maximizes paper-loading speed and minimizes interference with recorder components. Instantaneous selection of eight chart-drive speeds from 1 to 250 mm/sec. Optional accessories include time and event markers, 10:1 speed reduction device and total remote controlled operation.—*Edin Co., Inc., 207 Main St., Worcester 8, Mass.*

For more information circle **298** on inquiry card.

TAPE RECORDER



New Miniature Tape Recorder simultaneously records data (1 to 13 in-line channels) from tests conducted under severe environmental and extremely limited space conditions. Tape will survive high impacts at termination of tests without loss of record. Recording time 120 seconds @ 7½ ips.—*Engdahl Enterprises, Arcadia, Calif.*

For more information circle **299** on inquiry card.

ACCELERATION PICKUP

New medium-high natural frequency Model GAH utilizes an ac variable linear transformer for continuous resolution and high sensitivity; is available in ranges from ± 0.1 G to ± 20 G, with v_o/v_i ratio as high as 3; can be adapted to inputs from 3 to 115 v and any frequency from 400 to 5000 cps. Effect of temperature extremes (−65°F or 185°F) is about 1% of output at room temperatures.—*Genisco, Inc., 2233 Federal Ave., Los Angeles 64, Calif.*

For more information circle **300** on inquiry card.

CINTEL

FLYING-SPOT PARTICLE RESOLVER

Automatically counts and sizes particles, 2 to 1000μ. This range extends indefinitely by electron micrograph techniques.
Basically a flying spot scanner, the instrument includes a magnetic memory for elimination of double counts, a computer for size analysis, and digital readout.
Cintel Particle Resolvers are in use by:
E. I. DuPont de Nemours & Company, Inc.
Monsanto Chemical Company
Union Carbide & Carbon Corporation

see it at: Instrument-Automation Conference, Philadelphia BOOTH 537 Sept. 15-19

SPECIFICATION:
Magnification: x200 to x800 diameters.
Resolution: 0.1μ.
Definition: 700 lines.
Picture Size: 8 x 8 ins.
Counting: Automatic. Min. particle size 2.0μ.
Count Accuracy: ±2%.
Sizing: Automatic, into 11 groups.
Size and Count Time: 8 secs.

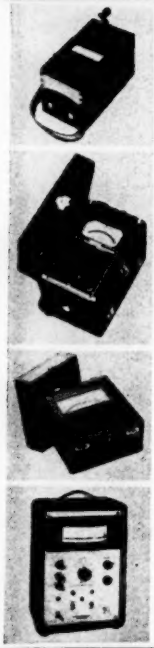
The immense resolution, speed and accuracy of this new 'Cintel' tool brings automation to the physicist as well as the engineer.

Exclusive Sales and Service in U.S.A.
MARCONI instruments
111 Cedar Lane, Englewood, N. J.

For more information circle **115** on inquiry card.

For more information circle **116** on inquiry card.

MEGOHMER
INSULATION TESTERS



GENERATOR TYPES

MINOR—Dwarf Size
500V, 50 Megohms
MAJOR—Small Size
Constant Voltage 500V
Megohm & Ohm Scales
STANDARD—Heavy Duty
500/1000V
up to 2000 Megs.

BATTERY VIBRATOR TYPES

NON-CRANKING
MODEL B-6—0-200 Megs.
2000 Ohms, AC-DC Volts
MODEL B-7—20/200 Megs.
200/20,000 Ohms.

PLUG IN TYPE

MODEL P-1 for
PRODUCTION TESTING
115V AC line operated
500/1000V
100/1000/2000 Megohms

ELECTRONIC TYPE

20,000,000 Megohms
MODEL 29A with 11 ranges
Range 300,000 to
20,000,000 megohms
Test Potentials
85V/500V

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For more information circle **117** on inquiry card.

The Computer Handbook

edited by M. H. Aronson. A clear introduction to the entire field of electronic computers and data processors. Presentations by computer manufacturers at the Second Computer Clinic. Paperbound, 72 pages, 1956, $2.00

Maintenance and Servicing of Electrical Instruments

by James Spencer. Useful to all instrument users, service men, switchboard attendants, testing engineers, and others, this book covers construction, testing, applications, principles of operation and maintenance of all kinds of electrical indicating instruments. Clothbound, 274 illustrations, 280 pages, 1951 (third edition), $2.00

Process Control Analysis

by M. H. LaJoy and E. A. Baillif. An essential first step in analysis of closed-loop controlled processes via frequency response of the system. Clothbound, 72 pages, 1956, $2.00

Process Control

by A. J. Young. A "must" for all who have to do with the automatic control of industrial processes, this book combines for the first time the practical "how" and the theoretical "why". Paperbound, 134 pages, 1957 (second printing), $2.00

The Instruments Publishing Co.

845 Ridge Ave., Pittsburgh 12, Pa.

NEW INSTRUMENTS

DIGITAL VOLT-OHMETER

New portable (26 lb) all-electronic Model 400-B indicates to three decimal places on easy-to-read Nixie tubes arranged in line on front panel, assuring fast readings from any angle. It measures positive or negative direct voltages from 0.01 to 1000, alternating voltages to 1000, and resistances from 10 ohms to 1 megohm. On ac measurements, it measures up to 100 kc with standard probe. Available from stock.—*Franklin Electronics, Inc., Dept. 556, Bridgeport, Pa.*

For more information circle **301** on inquiry card.

PLATE AND FILM COMPARATOR

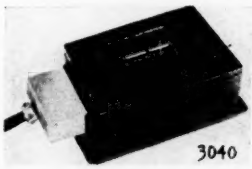
New Coordinate Plate & Film Comparator, especially useful for ultracentrifuge and electrophoresis plates

and films, reads to 0.002 mm; has standard magnification of 15× and 50x100 mm measuring range. Available: objectives for other magnifications, and holders for larger plates or films.—*Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill.*

For more information circle **302** on inquiry card.

SAMPLING SWITCH

New Electrocom high-speed solid-state commutator has 45 non-shorting channels sampled 20 times per

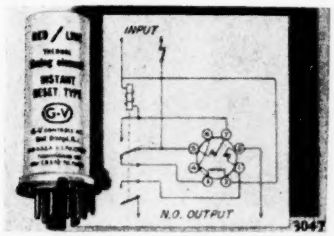


second; accepts signals from 0 to +5 vdc and produces a train of noise-free PAM waveforms with rise and fall times not exceeding 0.5% of full-scale pulse. "On" time is continuously adjustable from 0% to 100% of duty cycle. Preselected repetition rates are selected by proper wiring to mating plugs. Unit withstands shock, vibration, temperature and humidity; is 6" long; weighs less than 2¼ lb; requires less than 3 watts @ 28 vdc.—*General Devices, Inc., Princeton, N. J.*

For more information circle **303** on inquiry card.

INSTANT RESET TIMER

New Type DM Thermal Timing Element is instantly reset, either at end of cycle or part way through,

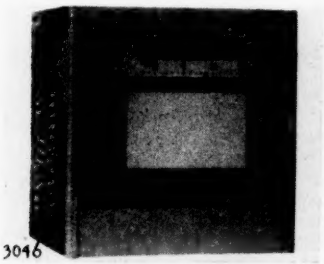


when combined with a small magnetic relay in circuit illustrated. (Magnetic relay with dp-dt contacts and coil for circuit voltage used, is ordinarily supplied by user.) Units are available for relay periods from 5 sec to 6 min and for operating voltages from 6.3 to 230; can be used interchangeably on ac or dc.—*G. V. Controls Inc., 28 Hollywood Plaza, E. Orange, N.J.*

For more information circle **304** on inquiry card.

SEGMENTAL RECORDER

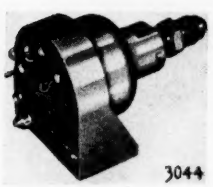
New multi-channel Model 156 Segmental Recorder gives visual on-the-spot data plotting to supplement non-



indicating scanning systems; features a separate 5½" x 6" graph of data versus time for each source input; can plot up to 192 different channels (192 separate graphs); is also available with 24, 32, 48, or 96 channels. A complete line of accessories is available.—*Gilmore Industries, Inc., 13015 Woodland Ave., Cleveland 20, Ohio.*

For more information circle **305** on inquiry card.

PRESSURE PICKUP

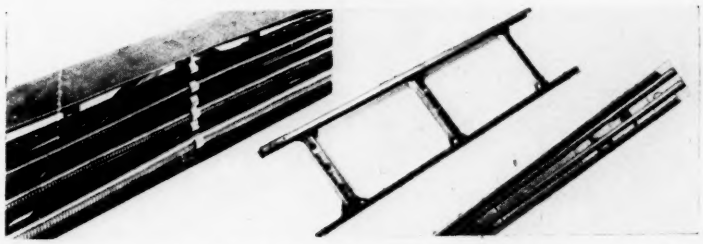


New Model 461227, of Bourdon-tube type, features resolution of up to 400 wires; is available in pressure ranges from 200 to 10,000 psia, psid or psig, and in wire-wound-resistor ranges from 3000 to 16,000 ohms depending on resolution desired.—*G. M. Giannini & Co., Inc., 918 E. Green St., Pasadena 1, Calif.*

For more information circle **306** on inquiry card.

SUPPORTS CUT COSTS

Add Your Name to our ever-growing list of satisfied customers who say, with a twinkle in their eyes: "We *saved* by using P-W."



Supports—Expanded and solid metal Trays and Ladder—in *Galvanized Steel* and *Aluminum*, to hold Power and Control Cables and Instrument Tubing. Specified and Approved For All Types of Governmental, Utility and Industrial Jobs.

The only system that *eliminates field cutting* and *provides 100% Galvanized Coverage*. Goes up like erector set. Pick out piece and install with drive rivets. (*Does away* with measuring, cutting, drilling and time-consuming bolts, nuts and washers or hinges.)

Write today for New Catalog No. 858 and literature. *Save Money* by Contacting our Representative or P-W direct.

P-W INDUSTRIES, INC. ***Manufacturers,***

Duncan and Melrose Sts., Philadelphia 24, Pa.

For more information circle **118** on inquiry card.

CAN YOU USE THESE FEATURES IN

VARIABLE SPEED DRIVES AND DIFFERENTIAL TRANSMISSIONS?

- **Full torque at zero speed**
- **Smoothly adjustable through zero speed**
- **Draw accuracies of .01%**
- **Shockless starts • Fully reversing**
- **Output speed ranges from 0-7000 rpm**

Consider SPECON drives, transmissions and gear boxes for your variable speed drive requirements.

Designed and produced by Stratos, the family of SPECON drives and transmissions is shown in a new free booklet — including capacity charts and output speed regulation.

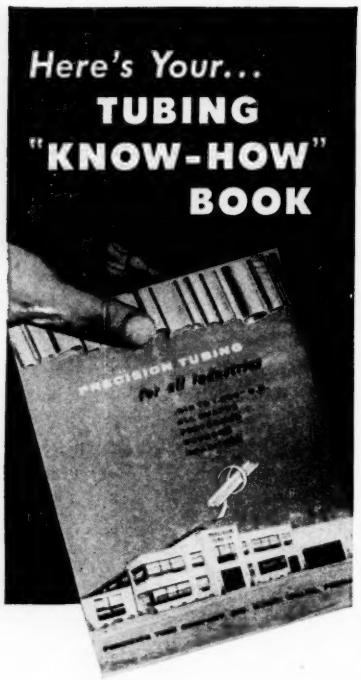
Write today to: SPECON

Stratos Industrial Products Branch #42, Route 109, West Babylon, N.Y.

Turbo-Expanders and Compressors • Pneumatic Pressure Regulators • SPECON Variable Speed Drives and Transmissions

The differential gearing of SPECON mechanical transmissions and electrical drives is available where gear boxes alone are needed. Special units for specific requirements are a SPECON specialty — standard sizes up to 75 hp are also available.

For more information circle **119** on inquiry card.



FACTS ON...

- **HOW TO SELECT**
- **TEMPER... ALLOYS**
- **WORKING PROPERTIES**
- **TOLERANCES of TUBING**

Here's a data book every engineer, purchasor and user of fine alloy tubing should have as a reference. Covers how to select tubing, the properties to look for, typical applications . . . tolerances, temper and alloys. Discusses drawing, annealing, finishing and testing. Gives range of sizes, length tolerances. Data on Bourdon tubing, pointer tubing and the exclusive Precision Coaxitube.

This booklet is available for use as a reference and buyer's guide to those sending requests on company letterheads to Dept. 7, Precision Tube Company, North Wales, Pa.

GET YOUR COPY...
NO CHARGE OR OBLIGATION!

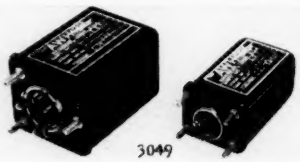
PRECISION TUBE COMPANY

For more information circle **120** on inquiry card.

NEW INSTRUMENTS

TRANSISTORIZED TIMERS

New Electronic Time Delays use a transistorized *R-C* network to eliminate moving parts except load

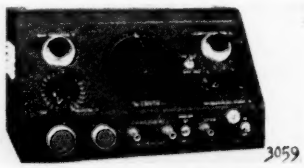


switching relay; offer high reliability under extreme conditions of temperature, vibration and shock. Time delays 0.05 sec to 1 min. Two styles: miniature 31200 Series, contact arrangements up to 4 p-dt; subminiature 31300 Series, contact arrangements up to dp-dt.—*The A. W. Haydon Co., Waterbury* 20, *Conn.*

For more information circle **307** on inquiry card.

UNIVERSAL RATIOMETER

New Model HM, for rapid production testing, features accuracies of 0.05% to 0.1% in measurement of

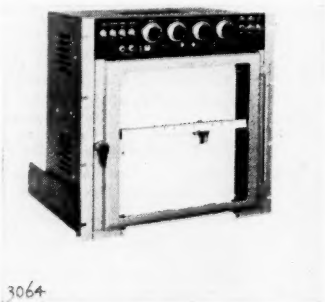


transformer voltage ratios, absolute voltages, impedance ratios, absolute impedances and phase angle, etc.; is operable at test frequencies of 60, 400 and 1,000 cps.—*The Liquidometer Corp., Skillman Ave., 36th & 37th Sts., Long Island City* 1, *N. Y.*

For more information circle **308** on inquiry card.

X-Y RECORDER

New Model 6 Autograf is electrically similar to Model 4 but has chart advance mechanism. It accepts a roll

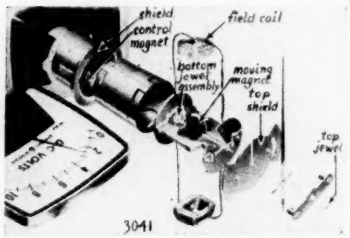


of up to 100 complete charts which can be advanced into place one at a time by manual or automatic means. —*F. L. Moseley Co.,* 409 *N. Fair Oaks Ave., Pasadena, Calif.*

For more information circle **309** on inquiry card.

PANEL INSTRUMENTS

New DW-91 (2½") and DO-91 (3½") ac and dc instruments, for switchboard or panel use, are said



to be "actually easier to read than many larger-sized instruments." All dc instruments are self-shielded, allowing cluster mounting without interaction and minimizing effects of stray flux. Exclusive moving-magnet mechanism used in dc ratings (except ammeters below 5 ma) eliminates zero set: control springs are replaced by a control magnet; in de-energized condition, moving magnet with attached pointer aligns with control-magnet, locating pointer at zero. All instruments are accurate to within 2% of full-scale.—*General Electric Co., Schenectady* 5, *N. Y.*

For more information circle **310** on inquiry card.

SOUND TRACK DEVELOPER

New Magna-See solution makes visible the sound track recorded on magnetic tapes. Magna-See Type PR (for pulse recording) provides a fast and accurate way to visually inspect tape for head azimuth (alignment), track uniformity, balance and head wear. Magna-See Kit includes a ½-pint can of Type PR solution, a plastic bath, a magnifier eyepiece, and a roll of pressure-sensitive tape with five glass slides to make permanent copies of visible tracks.—*Reeves Soundcraft Corp.,* 10 *E. 52nd St., New York* 22, *N. Y.*

For more information circle **311** on inquiry card.

SIX-DIGIT VOLTMETER

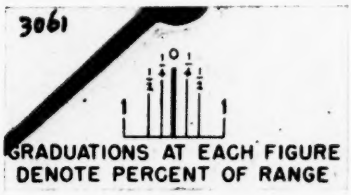
New Model 6703 can measure voltages from 0.001 to 100 automatically at about four readings per minute

instantly displayed in 1" illuminated numerals with plus or minus sign and decimal point; is automatically calibrated; can operate an IBM Summary Punch machine.—*Non-Linear Systems, Inc., Del Mar, Calif.*

For more information circle **312** on inquiry card.

TEST GAGE

New 8"-dial Type 1080 Ashcroft Maxitest, for testing pressure instruments to 10,000 psi, 0-30" vacuum,

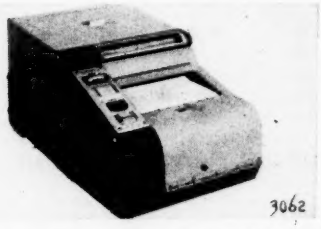


and 15 or 30 psi & 30" vacuum compound, features movable dial graduation tabs which indicate deviations from standard reading in terms of percent of total error. Tabs are positioned at major dial graduation points (there are no intermediate dial graduations). Each tab can be precisely set against a Standard.—*Manning, Maxwell & Moore, Inc., 250 E. Main St., Stratford, Conn.*

For more information circle **313** on inquiry card.

25-CHANNEL OSCILLOGRAPH

New D/R 616 25-channel direct-recording direct-readout oscillograph has recording speed range of 0.5 to



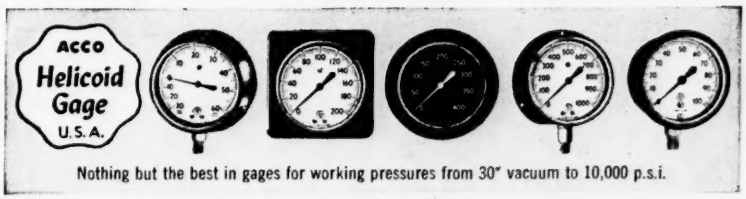
50 ips and writing speeds above 30,000 ips. Photographic records of galvanometer traces appear rapidly on 7" paper and require no chemical development. Trace identification by light-beam interruption. Record can be ejected continuously for immediate inspection. Automatic roll-up can be used also for storage of record at operator's discretion.—*Midwestern Instruments, 3401 So. Harvard, Tulsa, Okla.*

For more information circle **314** on inquiry card.

SIZE 10 MOTOR

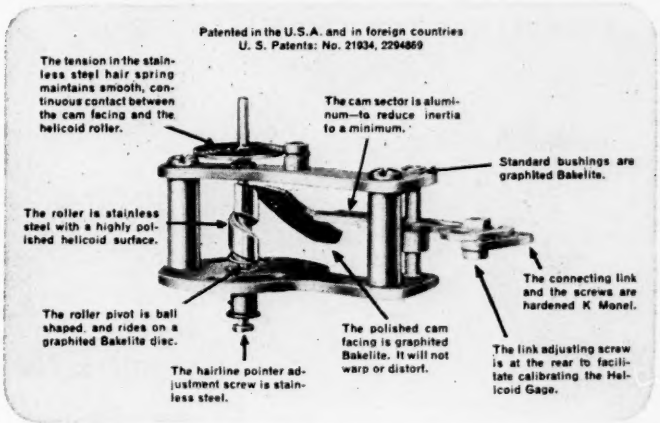
New hysteresis synchronous motor in BuORD size 10 with 1 3/16" max length will operate directly from 115-v line, 400 cps, single- or 3-phase, delivering 0.12 oz-in pull-out torque at 8000 rpm; can be supplied with gearhead with 2⅛" or 2⅜" max length depending on ratio. Slip clutch is available without increasing overall length. Both gearhead and clutch are encased with motor in a one-piece aluminum housing.—*Servomechanisms, Inc., Mechatrol Div., 1200 Prospect Ave., Westbury, L. I., N. Y.*

For more information circle **315** on inquiry card.



Nothing but the best in gages for working pressures from 30" vacuum to 10,000 p.s.i.

These details of Helicoid gage design assure longer life and enduring accuracy


Patented in the U.S.A. and in foreign countries
U. S. Patents: No. 21934, 2294869
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is aluminum—to reduce inertia to a minimum.
Standard bushings are graphited Bakelite.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped, and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

The superiority of Helicoid Gages is most evident in severe service—wherever a gage is subjected to violent pressure pulsations or severe mechanical vibrations.

The *sustained accuracy* of Helicoid Gages over *millions of cycles* is explained by the details of design and construction of the Helicoid movement shown above. Such Helicoid features—protect against wear and corrosion and assure sensitivity, sustained accuracy and trouble-free operation.

The Chemical Gage

The Helicoid Chemical Gage has a guaranteed accuracy of plus or minus 1%. It is applicable for working pressures from 30" vacuum to 5000 p.s.i. and temperatures to 400° F. It is particularly suitable for chemicals and other viscous fluids which might clog or corrode a Bourdon tube. Pressure and/or vacuum is transmitted directly to the indicating gage element through deflection of a Teflon or Kel F sealing diaphragm.

Tubes built for millions of pressure pulsations

To fit the wide range of applications, Helicoid Bourdon tubes are available in four materials—alloy steel, K Monel, stainless steel and phosphor bronze.

All Helicoid tubes are made from seamless tubing and are carefully designed to give maximum torque and minimum stress. When used within the dial range, they will withstand many millions of pressure pulsations and will not stretch, leak or crack.

***For complete information on the Helicoid line of gages write for* Catalog G-52**

Helicoid gives you all these features at prices that are competitive in the quality gage field.

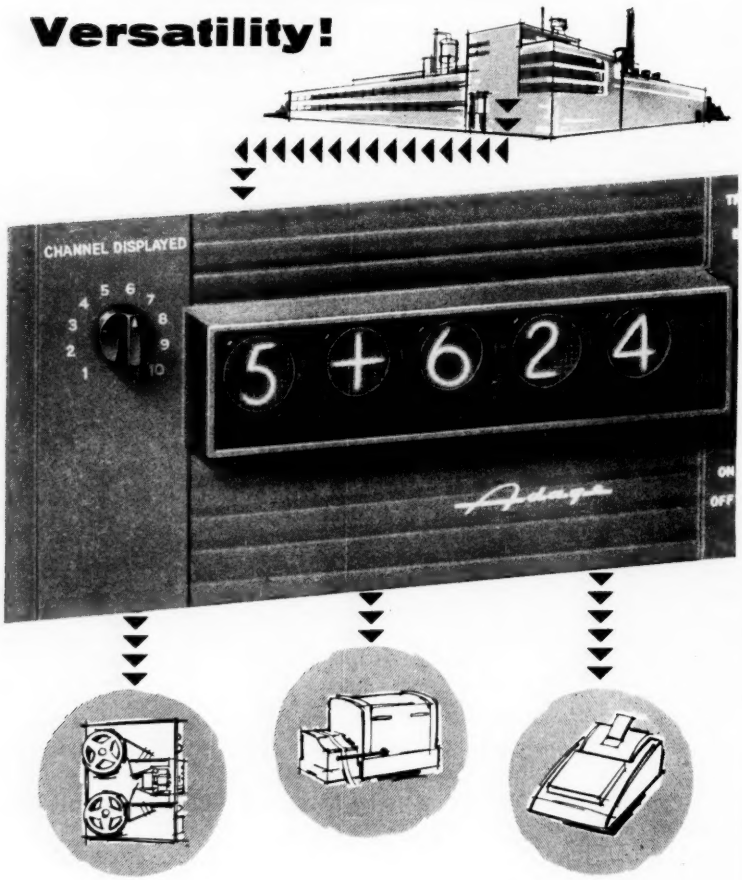
Helicoid Gage Division
AMERICAN CHAIN & CABLE

929-B Connecticut Avenue • Bridgeport 2, Connecticut

ACCO TRADE MARK

For more information circle 121 on inquiry card.

New Adage Converters Offer Unlimited Versatility!



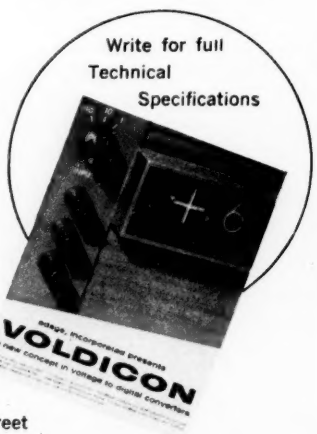
Unlimited Versatility? — a large statement. But the facts back it up! Voldicon will translate inputs from any source into any storage device.

Name your input: thermocouple, strain gage, telemetry data, analog computer (there are too many possibilities to list here) . . . Name your output: magnetic tape, tape punch, printer, digital computer . . . Voldicon will handle any combination.

Whatever your needs there is a Voldicon model designed to answer your problems . . . well within your budget.

NEW VOLDICON FEATURES:

- **New Transistor Design**
- **New Speed** — up to 10,000 separate conversions per second
- **New Accuracy and Reliability**



Adage INCORPORATED

Department IA-8, 92 Main Street
Cambridge 42, Mass.

For more information circle **122 on inquiry card.**

NEW INSTRUMENTS

HEAT EXCHANGERS

New Summer-Winter models of maker's Sectional Aero Heat Exchangers feature operation completely protected from freezing in extreme winter climates: enclose air-modulating dampers in a casing and provide for restriction of air supply by manually-operated damper in winter. Unit water-cooling capacities up to 18 million Btu/hr.—*Niagara Blower Co., 405 Lexington Ave., New York 17, N. Y.*

For more information circle **316** on inquiry card.

AIRBORNE COMMUTATOR

New unique all-solid-state airborne commutator weighs less than 12 oz and occupies less than 35 cu in; commutates 30 channels at rates up to 2500 samples per second or any IRIC commutation rate, operates at 40 G acceleration and temperatures from 0°C to 85°C.—*Wiancko Engineering Co., 255 No. Halstead Ave., Pasadena, Calif.*

For more information circle **317** on inquiry card.

PRINTED CIRCUIT TRIMMER

New Subminiature Type TPC performs dependably in applications where operation ranges from —55° C to 225°C. Resistance ranges are available from 100 to 30 kilohms. Power rating 1 watt @ 75°C derated to zero at 225°C. A 37-turn screw adjustment permits fine trimming. Spacing of leads is in multiples of 0.1".—*Technology Instrument Corp., 531 Main St., Acton, Mass.*

For more information circle **318** on inquiry card.

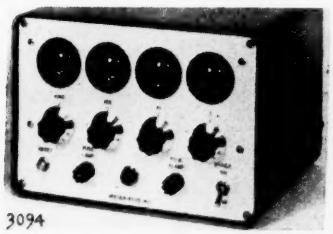
ILLUMINATION CONTROLLER

New Model 1099 Luminaire Illumination Control monitors light levels and actuates a relay to switch lights on or off automatically without regard to time of day, temperature, or weather conditions, with no consumption of electrical power except during a 30-sec switching cycle. —*Weston Instruments Div., Daystrom Inc., Newark 12, N. J.*

For more information circle **319** on inquiry card.

PREDETERMINING COUNTERS

New transistorized Count-Pak Model R standard models are available in 2, 3 and 4 decades. Additional decades,



and multiple groups of presetting controls for sequential predetermining, can be furnished on request. Glow-transfer cold-cathode counting tubes operate at speeds up to 5,000 counts per second. Counters will automatically recycle at counting speeds up to 1,000 cps without losing counts.—*Veeder-Root Inc., Hartford 2, Conn.*

For more information circle **320** on inquiry card.

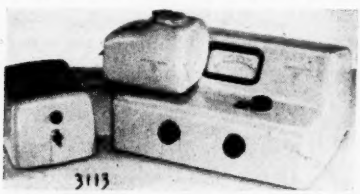
FREQUENCY-PERIOD COUNTER AND DIGITAL READOUT

New Model 211B combines high-speed electronic counting and in-line in-plane digital presentation in one package, costing 20% less than the two separate instruments previously required to perform the same function; features 2¼" numerals, 0 to 220 kc frequency range, 10 usec to 100,000-sec period range, and a memory circuit that holds readings while counter cycles to accumulate new data. Each digit comprises 40 small long-life neon bulbs, obviating risk of misreading because of lamp failure, and is readable 150 ft away.—*Computer Measurements Corp., 5528 Vineland Ave., North Hollywood, Calif.*

For more information circle **321** on inquiry card.

COLOR ANALYZER

New Spectronic Color Analyzer permits extremely accurate readings in percent reflectance of paints, tex-

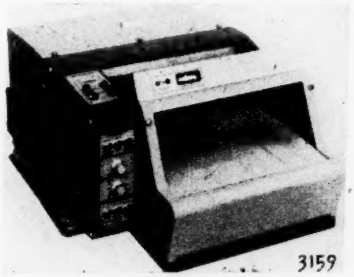


tiles, plastics, inks, glass, etc. It comprises B & L Spectronic 20 Spectrophotometer and Reflectance Attachment. Specially-designed B & L Trichromatic Chart permits quick conversion of reflectance readings to standard CIE trichromatic values.—*Bausch & Lomb Optical Co., 92049 St. Paul St., Rochester 2, N. Y.*

For more information circle **322** on inquiry card.

OSCILLOGRAPH

New Model 606 D/R is an advanced version of Model 602 with new features including flash timing up to



1000 cps; all-purpose versatility with 5 magazine types; extremely fast or slow recording speeds; extended range for frequency response; trace writing speed of 50,000 ips; linear, log or special (to order) grid lines; sharp focus trace lines at all speeds; recording on standard photographic paper or photographic film as well as on high-speed direct-printout paper activated by a high-intensity light source obviating need for a dark room; provisions for adjusting recording lamp current to recommended value. Extended galvanometer frequency range up to 5,000 cps is available, combined with a writing speed capability of 50,000 ips.—*Midwestern Instruments, 41st & Sheridan, Tulsa, Oklahoma.*

For more information circle **323** on inquiry card.

LINE VOLTAGE REGULATORS

New tubeless high-performance 60-cps line voltage regulators specifically designed to meet applicable MIL specs are available in eight standard models, from 500 va to 2000 va in two grades of MIL-T-27A. Standard input voltage 100-130 v 60 cps (180-240 v and 190-250 v on special order). Standard (nominal) output voltage 115 v 60 cps (208 and 230 v on special order), held within 1% for worst possible combination of rated input changes and 0-100% load variations. Recovery time (to 1% region after 10% line step or 25% load step) <ms. Efficiency about 85% a full load nominal input. Output power available in integral multiples of 500 va up to 10 kva, single phase.—*NJE Corp., 345 Carnegie Ave., Kenilworth, N. J.*

For more information circle **324** on inquiry card.

RACK PANELS

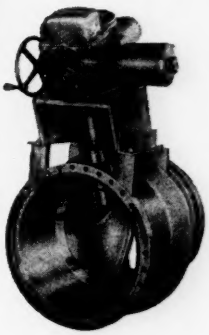
New reversible 19" standard blank rack panels come in two combinations: black wrinkle on one side with gray wrinkle on the other, or gray hammertone on one side with brown hammertone on the other; are available in aluminum and steel from 1¾" to 21" high.—*Premier Metal Products Co., 337 Manida St., New York 19, N. Y.*

For more information circle **325** on inquiry card.

Your plant needs

ROCKWELL VALVES *like these*

"Kwikleen" slide valve for powdered coal, granular materials, flue gases with high solids content, etc.; solids accumulations easily cleaned out by removing bottom plate.



"Stress-seal" butterfly valve for tight shut-off of hot, corrosive or dirty gases to 1300° F. and higher, at 200 p.s.i. Alloy stress band in valve body is inflated by external gas pressure to effect tight seal.

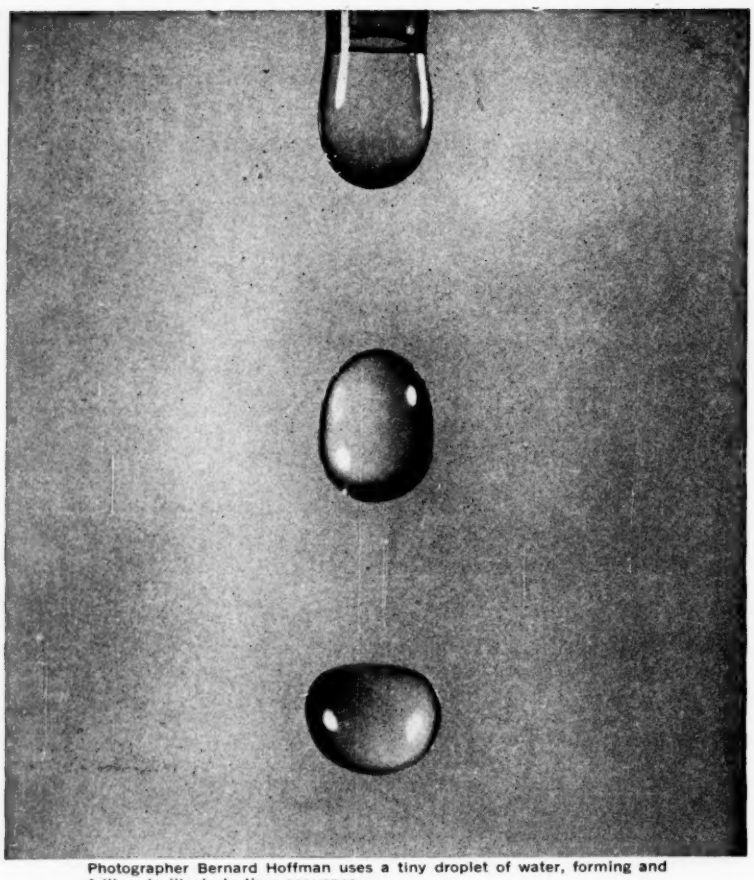
Butterfly valve with simplified bracket and linkage to air operator and valve disc positioner; provides maximum adjustment, minimizes friction, eliminates backlash, chatter and hunting, reduces power requirement in close control applications.

"Slim-Jim" wafer type butterfly valve for low pressure air, gas or liquids; low cost, light, simple, space-saving, easy to install.

What's your valve problem?

W. S. ROCKWELL COMPANY
2128 ELIOT STREET
FAIRFIELD, CONN.

For more information circle **123** on inquiry card.



Photographer Bernard Hoffman uses a tiny droplet of water, forming and falling, to illustrate time sequence.

Controlling Time in Fluid Engineering

Even in simple hydrodynamic situations like the one pictured above, time sequence is measured in micro-seconds. More often than not, other factors – such as pressure, volume and flow – all tend to complicate fluid time control. That's where the engineering leadership of S. Morgan Smith can help you most.

SMS Rotovalves, for example, will give you the closest control of closing time . . . as quick as one second or as slow as needed. Their fast initial shut-off limits reversal of flow, and closure is positive and drop-tight. Rotovalves are easier to operate, requiring less power for mechanical or electrical operation, and their full line opening means less head loss and lower pumping costs.

SMS offers you a complete line of standard Rotovalves, Ball Valves and R-S Butterfly Valves, as well as special application engineering help. To obtain full information, call our nearest representative, or write S. Morgan Smith Company, York, Penna.

S. MORGAN SMITH SMS HYDRODYNAMICS

AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED, TORONTO

Rotovalves • Ball Valves • R-S Butterfly Valves • Free-Discharge Valves • Liquid Heaters • Pumps • Hydraulic Turbines & Accessories

For more information circle **124** on inquiry card.

NEW INSTRUMENTS

FLOW RATE TRANSMITTER

New MPT-50 is a completely new instrument embodying unusual design innovations, e.g. a magnetically-coupled position converter utilizing an iron strip formed into a helix and caused to rotate by up or down motion of a small magnet on metering float extension within stainless-steel rotameter extension tube, action being analogous to that of a rack and pinion. Affixed to top of this converter is a flow sensing cam which is rotameter's calibration curve plotted on polar coordinates. This cam is characterized to meet any requirements. Transmitter has no contact with converter's moving parts. Unit is unaffected by vibration and a wide range of temperatures. Supply air pressure variations from 20 to 25 psi have no effect on output pressure. —*Brooks Rotameter Co., Lansdale, Pa.*

For more information circle **326** on inquiry card.

PULSE TRANSFORMERS

New miniature pulse transformers designed for military applications are ⅜" long with ½" OD; are available as blocking oscillator pulse transformers covering a range of pulse widths from 0.05 usec to 2.0 usec, and pulse coupling transformers covering a wide range of impedance ratios and pulse widths.—*ESC Corp., Electronic Components Div., 534 Bergen Blvd., Palisades Park, N. J.*

For more information circle **327** on inquiry card.

DIGITAL DIALS

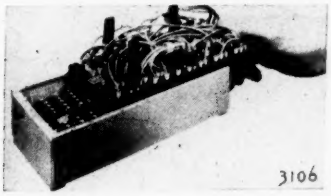
New 1300 Series direct-reading Microdials reduce forced-fast-reading and -setting errors. Mounting con-

trol knob directly on shaft to be controlled (no gearing) prevents backlash. Sealed construction withstands severe environmental conditions. Optional finger-tip brake (on 3-digit dials only) retains settings when desired.—*Borg Equipment Div., 120 S. Main St., Janesville, Wis.*

For more information circle **328** on inquiry card.

PROGRAMMING SYSTEM

New miniaturized A-MP 240 Patchcord Programming Systems, for split-second reprogramming of airborne



circuitry, weighs 3¼ lb, withstands shock and vibration. Seating of patchcord pins is also designed for shock resistance.—*AMP Inc., Harrisburg, Pa.*

For more information circle **329** on inquiry card.

TRANSISTOR TEST SET

New Model KP-2, for analyzing transistors at frequencies from 100 cps to 200 kc, offers current range of 100 ua to 1 amp with two regulated semiconductor power supplies for bias voltages and currents. Special models available for use up to 2 amp. Direct measurements are based on "h" parameters using basic simple and straightforward circuitry for optimal reliability of test results. —*Baird-Atomic, Inc., 33 University Rd., Cambridge 38, Mass.*

For more information circle **330** on inquiry card.

HIGH IMPEDANCE VTVM

New Model 311 vacuum-tube-volt-ohmmeter with an input impedance of 22 megohms and other advanced characteristics is approved by national service managers of Admiral, Motorola, and Zenith; is said to offer a number of improvements not found in other VTVM's among them DC/AC Ohms Probe featuring exclusive Timesaver Tip.—*Simpson Electric Co., 5200 W. Kinzie St., Chicago 44, Ill.*

For more information circle **331** on inquiry card.

HEAT EXCHANGERS

New improved standard and custom-designed high-capacity heat-transfer surfaces operate under reduced pressure with a high degree of heat exchange for cooling and heating.—*Tenney Engineering, Inc., Heat Transfer Div., 1090 Springfield Rd., Union, N. J.*

For more information circle **332** on inquiry card.

D/P CONTROLLER

New Type J99K explosion-proof differential pressure control has snap-action switch actuated when pressure on high side exceeds pressure on low side by preset amount, regardless of static pressure values. Cast iron base and aluminum cover permits use in Class I, Groups C & D; Class II, Groups E, F and G; Class III as defined by NEC. Many types of s-p switches available are rated for 15 and 20 amp at 115/230 vac.—*United Electric Controls Co., 79 School St., Watertown, Mass.*

For more information circle **333** on inquiry card.

FREQUENCY CONVERTER

New fully-transistorized Frequency Converter converts ac signals into either direct voltages or amplified pulse outputs; is especially suitable for aircraft or missile use; is made for both ac and dc power supplies. Full-scale input frequency adjustable from 300 to 900 cps; minimum frequency 10 cps; linearity 0.1%; long term stability 0.25%; operating ambient temperature range −65°F to 160°F.—*Fischer & Porter Co., 752 Jacksonville Rd., Hatboro, Pa.*

For more information circle **334** on inquiry card.

PICKUP CARRIER AMPLIFIERS

New Models CA3 and CA5 Strain Gage Carrier Amplifiers, for direct use in telemetering operate from airborne 28-vdc supply, provide an output of 0-5 vdc exactly proportional to pressure, acceleration, or structural load being measured; can be used with any strain-gage pickup; are transistorized throughout; withstand vibration up to 35 G in any axis as high as 2000 cps and temperatures from −65°F to 165°F.—*Statham Instruments, Inc., 12401 W. Olympic Blvd., Los Angeles 64, Calif.*

For more information circle **335** on inquiry card.

METERING VALVE KIT

New Assembly 280-25 is a micrometer handwheel kit for use with maker's 280 Series Metering Valves. It permits measurement of valve settings by establishing a reference point as to number of stem turns required to obtain a particular flow. It comes with all needed parts.—*Hoke, Inc., 231 South Dean St., Englewood, N. J.*

For more information circle **336** on inquiry card.

Stromberg-Carlson's new type "E" relay combines the time-proven characteristics of the type "A" relay with a mounting arrangement common to many other makes.

As the sketch above shows, our new frame mounting holes and coil terminal spacing allow you to specify these relays—*of "telephone quality"*—interchangeably with brands you have been using. Costs are competitive and expanded production means *prompt delivery.*

Welcome engineering features of the new "E" relay are—

★ **Contact spring assembly:** maximum of 20 Form A, 18 B, 10 C per relay.

★ **Coil:** single or double wound, with taper tab or solder type terminals at back of relay.

★ **Operating voltage:** 200 volts DC maximum.

You may order individual can covers in a choice of 3 sizes for the new relay, as well as for our type "A" and "C" relays.

For complete details and specifications on the "E" relay and other Stromberg-Carlson relays, send for your free copy of Catalog T-5000R.

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A DIVISION OF GENERAL DYNAMICS CORPORATION
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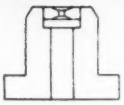
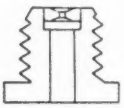
JEWEL BEARING ASSEMBLIES . . . .

for AIRCRAFT • ELECTRICAL
MECHANICAL and
MARINE
INSTRUMENTS





Sapphires set in brass, or other metal assemblies made in any quantity to close tolerance specifications are produced by Moser Jewel Company—*manufacturers of industrial jewels for over 50 years.*

Moser also provides highly polished pivots, staffs —silicon and spring loaded assemblies for high shock resistance.

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because they combine the most advanced features ever found in pressure, vacuum and compound gauges. There is a Marsh Gauge for every conceivable application.

MARSH Needle Throttling Valves...
because they are guaranteed to give micrometer regulation at HIGH pressures—pressure up to 10,000 psi—and any temperature up to 500° F.

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because they offer the precision and accuracy a precision industry demands. Most complete line; wide temperature ranges, dial sizes, patterns, finishes.

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MARSH *New catalog covers all details*

MARSH INSTRUMENT CO. *Sales Affiliate of Jas. P. Marsh Corp.* Dept. 42, Skokie, Ill.
Marsh Instrument & Valve Co., (Canada) Ltd., 8407 103rd St., Edmonton, Alberta, Canada. Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas

For more information circle **127** on inquiry card.

new plants and mergers

Consolidated Electrodynamics

CONSOLIDATED ELECTRODYNAMICS has completed construction of two 57,500-sq ft buildings for its Systems and Transducer divisions.

SUN ELECTRIC has acquired the manufacturing facilities and product line of the panel instrument department of **TEXAS INSTRUMENTS** and has integrated them into its Instrument Division.

BROOKFIELD ENGINEERING LABS. has moved into a 3,000-sq ft addition to its plant.

NARDA ULTRASONICS has formed a new Chemical Process Division, and has acquired a large property in Westbury to expand its production and laboratory facilities.

BARBER-COLMAN recently purchased the assets of the Kin-Dar Corp. relating to the production of inexpensive d-c motors. They will be manufactured and marketed by the Electrical Components Division of Barber-Colman.

EXPERIENCE
KNOW-HOW
FACILITIES
= PRECISION OPTICS

All are found at Plummer & Kershaw. On this we have built our reputation.

Automated production facilities have enabled us to manufacture ultra-critical and non-critical elements of highest accuracy and quality at lowest cost for industrial and commercial use.

We welcome the opportunity to place our experience, know-how and facilities at your disposal to solve your particular problem.

p&k **PLUMMER and KERSHAW**
2759 Frankford Ave., Philadelphia 34, Pa.
Request Bulletin 737 on your Letterhead

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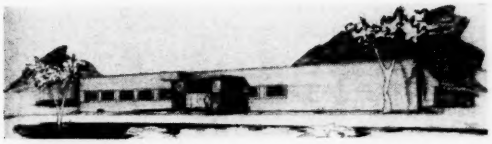


OFFNER ELECTRONICS has broken ground for a new $250,000 plant.

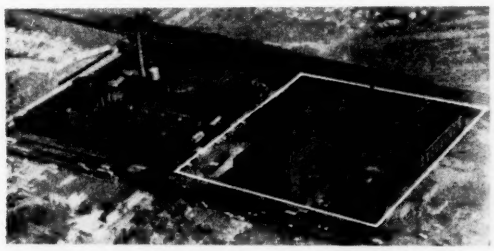
MASSA LABORATORIES has become a division of COHU ELECTRONICS, INC.

AMERICAN PHOTOCOPY EQUIPMENT (APECO) has moved to new 10.3-acre headquarters.

PYROMETER CO. OF AMERICA, a new firm formed in Penndel, Pa., will manufacture instruments, thermocouples, and accessories.

ACOUSTICA ASSOCS. has acquired **GENERAL ULTRASONICS CO.** which will be operated as a wholly-owned subsidiary.

HAYS MANUFACTURING CO. is now occupying a recently acquired 115,000-sq ft addition to its plant.



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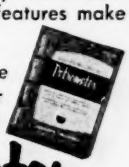
SERIES 1400
LIQUID DEPTH GAUGES

ACCURATE and EASY TO INSTALL

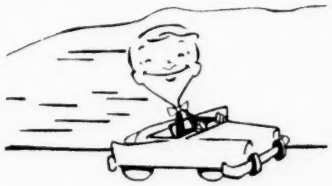
Available in 4 Models, Petrometer Series 1400 Tank Gauges operate on the sound principle of hydrostatic pressure. No moving parts, no expensive electrical or electronic equipment. Large vertical scale gives accurate, easy-to-see reading. And construction features make installation easy.

For complete information send for Bulletin 6004



Petrometer
CORPORATION
43-22 TENTH ST., LONG ISLAND CITY 1, N. Y.

For more information circle **130** on inquiry card.



FOR SPEEDY INFORMATION

Slow down long enough to note there is a key number at the end of product and literature reviews and at the foot of each ad. To speed more information your way, circle the corresponding number on the inquiry card bound in this issue. If the card has already been used, simply write the key number, the date of issue, and your name and address on a postal card and send c/o our Reader Service Dept.

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portable edging machine for plastic nameplates

Saves you money two ways:

1. *Do your own bevelling*
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* Bevels any stock thickness up to 3/16"
* One cutting tool makes any border width, by means of adjustable spindle

Write for illustrated fact sheet XB-1

See Demonstration at Booth #203 Wescon Show

new hermes ENGRAVING MACHINE CORP. 33-19 UNIVERSITY PLACE, NEW YORK 3, N. Y.

For more information circle **131** on inquiry card.

100% AUTOMATIC TANK GAUGING

Dependable remote reading tank contents gauges using a closed hydraulic transmission system. No power required.

Several sizes available. Approved by Underwriters Laboratories and Factory Mutual. UL approved switches.

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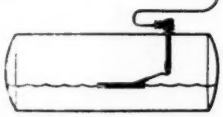

Since 1920 of proven quality

THE LIQUIDOMETER CORP.
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For more information circle **132** on inquiry card.

people in the news

D. E. Madden

S. S. Sievers

R. Kaufman

A. W. CASH VALVE MFG. CORP.'S vice president *Dean E. Madden* was elected president of **FLUID CONTROLS INSTITUTE.**

KINTEL DIV. of Cohu Electronics announces promotion of *Stanley S. Sievers* from assistant sales manager to sales manager.

DEL ELECTRONICS CORP. announces appointment of *Dr. Raymond Kaufman* as vice president and director of research.

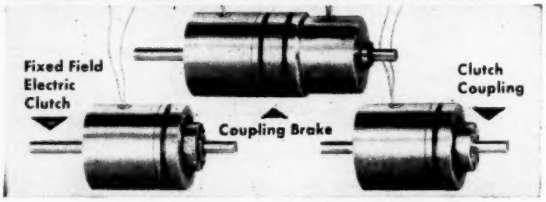
GEORGE H. BIRCHALL CO. INC., representing Uniflow Valve Corp., Customline Control Panels Inc. and Davis Instrument Div. in the New York Area, announces addition of *Alan J. Robertson* to its staff.

HOLEX INCORPORATED announces that *James G. Ramsay* was elected vice president in charge of sales, advertising, and public relations.

CLARY DYNAMICS DIV. OF CLARY CORP. has appointed *Albert W. Sommerfield* vice president, treasurer and member of the board of directors.

Introducing . . .

Simplatrol FIXED FIELD Electric Clutches



In Miniature and Small Sizes

Super compact for use in instruments or assemblies where space is at a premium and performance requirements are high.

Three styles of Simplatrol Fixed Field Clutches ranging from 7/8" to 3 1/8" diameter. Torque output ranges from 10 oz. inches to 100 lb. inches.

Simplatrol Diaphragm Makes The Difference!

The only functional moving part in actuation of Simplatrol Fixed Field Clutches.

When current is applied to magnet, the diaphragm yields as the armature is attracted to the rotor body. Engagement is extremely rapid, smooth and silent.

The Simplatrol principle has been proved by years of use and features a minimum of parts to maintain or replace.

Ask for literature and recommendations on Simplatrol Fixed Field Miniature and Small Electric Clutches and Brakes.

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24-8 SALISBURY ST., WORCESTER, MASS.
Representation in Key Industrial Areas

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BISMUTH
BRASS
CARBORUNDUM
CERAMIC
COPPER
*CORNING 707
*CORNING 7052
FERRITE
FERROX
**FLUORIDE, CALCIUM
**FLUORIDE, LITHIUM
GERMANIUM
INDIUM ANTIMONITE
INDOX
MELAMINE FIBER GLASS
MICA, SYNTHETIC
POTASSIUM BROMIDE
*PYREX
*QUARTZ, CRYSTAL
*QUARTZ, FUSED
**SAPPHIRE
**SODIUM CHLORIDE
**STEEL
STRONTIUM TITANATE
TITANIUM DIOXIDE
*VYCOR
*X-RAY LEAD GLASS
ALL TYPES KNOWN GLASS

*Carried in stock
**Purchased for orders

For more information circle **134** on inquiry card.

M. J. Rowe

W. Q. Nicholson

G. Tyson

AIRBORNE INSTRUMENTS LABS. a Div. of Cutler-Hammer has announced appointment of *Malcolm J. Rowe* as manager of marketing.

BJ ELECTRONICS, BORG-WARNER has appointed *William Q. Nicholson* as associate technical director and manager of engineering plans and programs.

TELEMETER MAGNETICS announces that *Graham Tyson* has been made Senior Applications Engineer for data handling systems.

VARIAN ASSOCIATES has appointed *Norman Hiestand* manager, product development of the instrument division.

MINNEAPOLIS-HONEYWELL'S BOSTON DIVISION announces that *C. B. Harrison* has been named marketing manager and will direct sales proposals to military and industrial customers in addition to heading advertising and sales promotion campaigns.

BENDIX AVIATION CORP. has named *L. E. Rasmussen* as general manager of the Cincinnati division.

MOORE PRODUCTS CO. announces appointment of *Joseph Jeffries* as Pittsburgh Branch Office Manager.

MINIATURE PRECISION BEARINGS announces appointment of *Harold H. Gillespie* as general manager of the Split Ballbearing Division.

RECORDING CHARTS

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*heat
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OUR EXCLUSIVE CONTINUOUS PRINTING METHOD GUARANTEES ACCURACY OF THE HIGHEST ORDER

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CUSTOM CHARTS FOR THE INSTRUMENT INDUSTRY

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BORESCOPES

For internal visual inspection from a few inches to 85 feet in length
Wide field of view
Interchangeable heads for varying angle of view
Standard models for most inspections
Special designs readily fabricated from stock parts

PERISCOPES

For remote observation of inaccessible places for hazardous processes
Designed for specific applications in any length, diameter, field of view or magnification

Describe your problem fully. Give diameter, length, irregularities and other particulars. Drawings helpful.

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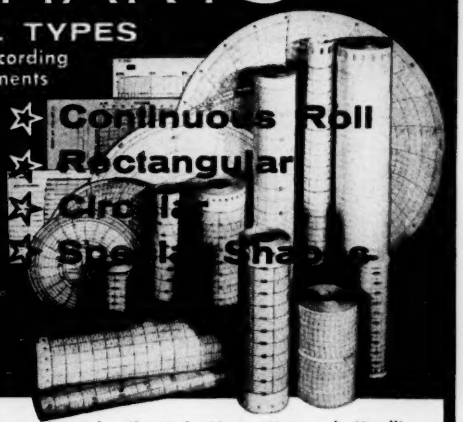
GUBELMAN CHARTS

ALL TYPES for Recording Instruments



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Charts for Ink, Electrical, Heat, Wax and Metallic Stylus-Recording.

Special time numbering, perforations, and graphic design cycles available to meet unusual requirements.

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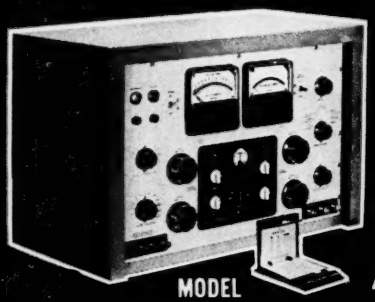
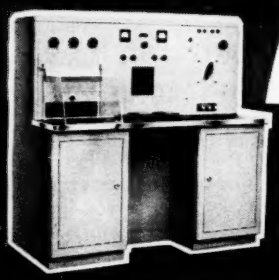


MODEL 829

a modern method of maintaining ACCURACY



MODEL 261B

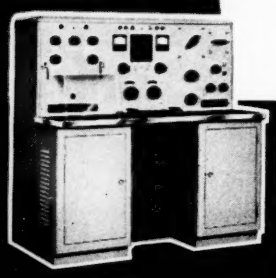
Superior and sustained quality control, through frequent calibration of test instruments, can be achieved by semi-skilled personnel using these self-contained standards.

Portable Model 829 calibrates both AC and DC meters over ranges from 0.25 millivolt to 2000 volts and 2 microamperes to 20 amperes. Direct reading accuracy of 1% (0.5% using charts supplied). Output frequency from 50 to 400 cps depending on line frequency used.

Net price $2,650.

Console Model 261B calibrates all types of AC meters to direct reading accuracies of 0.5% (0.25% using calibration charts) over frequency range of 50 to 1600 cps. Current range from 1.5 milliamperes to 200 amperes; voltage range from 75 millivolts to 1500 volts. Output of electronic power oscillator has less than 5% total harmonic content at 60 cycles.

Net price $9,250.



MODEL 262B

Model 262B Dual Potentiometer Standard calibrates DC electrical measuring instruments to direct reading accuracies of 0.1% (0.05% using calibration charts) through voltages ranging from 1 millivolt to 1500 volts and currents ranging from 1 microampere to 150 amperes. Employs Weston instruments and standard cells.

Net price $15,600.

Prices are f.o.b. Boonton, N.J. & subject to change without notice.

WE CAN HELP YOU

Technical and application data for our six basic models are fully described in a new 24-page catalog. Send for it today.

RFL *Radio Frequency* LABORATORIES, INC. Boonton, New Jersey, U.S.A.

For more information circle **137** on inquiry card.

new literature

AUTOMATION

GLASS CONTAINER MANUFACTURE. New equipment for glass feeder temperature control in container manufacture is described in Process Data Sheet 644 (3).—Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.
For more information circle **337** on inquiry card.

A-C AUXILIARY MILL CONTROL. 4-page Bulletin GEA-6702 discusses a-c auxiliary control for metal rolling and processing industries with power utilization levels up to 600 volts.—General Electric Co., Schenectady 5, N. Y.
For more information circle **338** on inquiry card.

HYDRAULIC CONTROL SYSTEMS and power units are described in 4-page Bulletin GR-58-4.—General Regulator Corp., 666 Fifth Ave., New York 19, N. Y.
For more information circle **339** on inquiry card.

PRODUCTION CONTROL SYSTEM. 8-page brochure describes new Hancock Telecontrol system which makes possible extension of automation benefits to general manufacturing systems; every piece of productive machinery in a plant is linked electrically to a central monitoring room.—Control Systems Co., a Div. of Hancock Industries, Inc., Jackson, Mich.
For more information circle **340** on inquiry card.

REMOTE CONTROLS. 8-page catalog covers, Hydra-Trol self-contained manual-hydraulic positioning devices.—Crown Controls Div., Trimount Instrument Co., 3119 W. Lake St., Chicago 12, Ill.
For more information circle **341** on inquiry card.

COUNTING AND PACKAGING MACHINE. 2-page leaflet describes Count-O-Matic "E" which feeds product continuously into alternate receptacles and counts them.—U. S. Engineering Co., 40-21½ 22nd St., Long Island City, N. Y.
For more information circle **342** on inquiry card.

FEEDING SYSTEMS. Loss-in-weight gravimetric feeders for solids or liquids are subject of 8-page Bulletin 32-R2. System maintains accuracy with ½% of set feed rate over the entire range of 10:1, 20:1 or up to 50:1.—Omega Machine Co., 345 Harris Ave., Providence 1, R. I.
For more information circle **343** on inquiry card.

HOMOGENIZER-DISPENSER. 4-page bulletin describes mechanical high-frequency wet-milling and mixing device.—Bronwill Div., Will Corp., P. O. Box 127, Brighton Station, Rochester 10, N. Y.
For more information circle **344** on inquiry card.

SUGAR INDUSTRY AUTOMATION. 12-page Catalog 90-260-10 discusses instrumentation for the cane sugar industry.—Fischer & Porter Co., 550 Jacksonville Rd., Hatboro, Penna.
For more information circle **345** on inquiry card.

INSTRUMENT APPLICATIONS. 8-page king-size Spring 1958 issue of "Modern Precision" contains nine articles on uses of measuring and automatic-control instruments in missile plants, metals industries, research labs., etc. —Leeds & Northrup Co., 4907 Stenton Ave., Phila. 44, Pa.

For more information circle **346** on inquiry card.

PAPER MILL DEVICES. 4-page Technical Bulletin 90-130-25 discusses benefits of "Instrumentation of Water and Waste Treatment in Pulp and Paper Mills."—Fischer & Porter Co., 540 Jacksonville Rd., Hatboro, Penna.

For more information circle **347** on inquiry card.

SERVOS

SERVOMOTOR. 2-page bulletin describes Model M-100 Size-11 60-cps servomotor which reaches full speed of 1460 rpm in 0.04 second and also has highest known servo damping characteristics.—Dynamic Instrument Corp., 59 New York Ave., Westbury, L. I., N. Y.

For more information circle **348** on inquiry card.

SYNCHROS. 2-page data sheets on R915-01 and R915-02 linear synchro transmitters; R980-01 compensated synchros resolver; R982 size 11, 4-wire synchros; Z5151, Z5161 and Z5191 size 25, high-accuracy resolvers.—Kearfott Co. Inc., 1378 Main Ave. Clifton, N. J.

For more information circle **349** on inquiry card.

GYROS. 6-page bulletin discusses precision gyros with rapid warm-up capabilities.—Kearfott Co. Inc., 1378 Main Ave., Clifton, N. J.

For more information circle **350** on inquiry card.

VALVES

WATER VALVES. Nine different automatic water control valves and their uses are described in 8-page bulletin G-5A.—Golden-Anderson Valve Specialty Co., 1285 Ridge Ave., Pittsburgh 33, Pa.

For more information circle **351** on inquiry card.

VALVES. 24-page Catalog V-58 illustrates and specifies magnetic and motorized valves for air, water, gas, steam, oil and refrigerants; includes solenoid coil rating tables.—The Mercoid Corp., 4201 Belmont Ave., Chicago 41, Ill.

For more information circle **352** on inquiry card.

MULTIPORT RELIEF VALVES. 8-page Bulletin 5200-A describes multiple-disc relief valves for steam systems, in sizes from 4" to 48", 0-25 to 0-100 psig; installation diagrams, data on selecting and specifying.—Cochrane Corp., 17th St. and Allegheny Ave., Phila. 32, Pa.

For more information circle **353** on inquiry card.

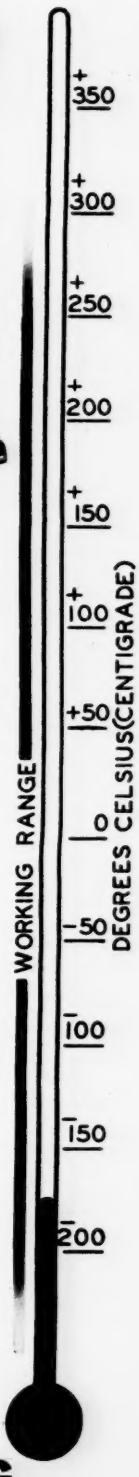
CONTROL VALVE. 2-page Bulletin 1053 describes Copes flow regulating valve which uses a horizontal rotating lever shaft instead of a sliding stem. —Copes-Vulcan Div., Blaw-Knox Co., 936 W. 26th St., Erie 4, Pa.

For more information circle **354** on inquiry card.

PUMP GOVERNOR. 2-page Bulletin 1046 describes Copes Type SDS-2 governor for either steam-or motor-driven

NEW LOX TEMPERATURE PROBE

Temperature range from
−200° C (or lower) to
+250° C (or higher)



This new liquid oxygen probe operates within the extraordinary working range designated by the drawing at right. Applications at even lower and higher temperatures are anticipated. We expect the probe to be useful down to the liquid Helium range. Model 134 provides 100 ohm variation in the range from −270 to −300° F, which corresponds to pure platinum wire having a resistance of 1380 ohms at 0° C. The high impedance level together with a capability for large power dissipation permits large voltage variations to be developed for telemetering purposes.

Contact us for Bulletin No. 5581. Also, we will be glad to propose on variations in calibration, calibration interchangeability, mounting and electrical connection provisions.

REC MODEL 134 SPECIFICATIONS—

- **Sensing Element.** Pure platinum wire with strain-free mounting and protected by ceramic coating.
- **Resistance.** 1380 ohms at 0° C is standard; lower and somewhat higher also possible.
- **Calibration Stability.** After 50 cycles from boiling water to LN_2, R_0 drifts less than 0.1 ohms which is equivalent to 0.02° C.
- **Interchangeability.** Standard adjustment is within 10 ohms (1.7° C) at 0° C to 2 ohms (0.3° C) at LN_2. On special order, far greater interchangeability (or reproducibility) is possible.
- **Time Constant.** 0.1 seconds in water at 3 ft. per second.
- **Self Heating Effect.** 2 watts per ° C in water at 3 ft. per second.
- **Vibration.** ½" DA to 30 g's and 30 g's to 2000 cps.
- **Pressure Test.** 6,000 psi. std; up to 16,000 psi is possible.
- **Thermal Shock.** May be plunged from boiling water into LN_2 and back to boiling water repeatedly.

***ENGINEERS*— Is your data file on temperature probes up to date?**

We will welcome your inquiry for information on the REC 134 (Bulletin No. 5581) or any of the many other temperature probes we manufacture; also for research and development or consultation.

REC

ROSEMOUNT ENGINEERING COMPANY

Dept. 1A-8

9424 Lyndale Ave. So., Minneapolis 20, Minn., TUxedo 1-2685

For more information circle **138** on inquiry card.

NEW LITERATURE

pumps, illustrates hook-ups, and gives selection specs.—Copes-Vulcan Div., Blaw-Knox Co., 936 W. 26th St., Erie 4, Pa.
For more information circle **355** on inquiry card.

FLOAT VALVES. 2-page Catalog Section V describes auxiliary-actuated Type 214 and 216 float valves which permit control of liquid levels within 1" limits in open or closed vessels.—Atlas Valve Co., 280 South St., Newark 5, N. J.
For more information circle **356** on inquiry card.

MANUAL REMOTE VALVE CONTROLS. 20-page Bulletin 5811 is a design manual on flexible shaft valve controls including valve couplings, remote operating terminals, standard reach rod controls, universal joints, valve couplings, and remote stations.—Stow Mfg. Co., 66 Shear St., Binghamton, N. Y.
For more information circle **357** on inquiry card.

PNEUMATIC PRODUCTS. 20-page Catalog C16 features air line filters, regulators, and lubricators. Includes performance characteristics, "quick sizing" charts, and specifications.—Watts Regulator Co., Industrial Div., Lawrence, Mass.
For more information circle **358** on inquiry card.

TEMPERATURE

TEMPERATURE CONTROLLER. 6-page Bulletin 3885 describes Alnor Pyrotroller which can be applied wherever a thermocouple can be used to measure temperature.—Illinois Testing Laboratories, Inc., 420 N. La Salle St., Chicago 10, Ill.
For more information circle **359** on inquiry card.

ENVIRONMENTAL TEST CHAMBERS. 4-page condensed catalog describes testers for temperature, humidity, altitude, sand and dust, fungus, rain and sunshine, and explosion.—Environmental Equipment Corp., 369 Linden St., Brooklyn 27, N. Y.
For more information circle **360** on inquiry card.

THERMOCOUPLE ASSEMBLIES described in new, 12-page Catalog Section E, are for heavy duty industrial applications.—Thermo Electric Co., Inc., Saddle Brook, N. J.
For more information circle **361** on inquiry card.

MINIATURE THERMOCOUPLES. 28-page consolidated catalog, describes four basic designs: gasket, bayonet, protected and shielded thermocouples.—Thermo Electric Co., Inc., Saddle Brook, N. J.
For more information circle **362** on inquiry card.

THERMISTOR APPLICATIONS. 16-page brochure gives specifications for nearly 400 different thermistors—including assemblies, matched pairs, beads, discs, washers, rods, probes, etc; includes fifteen different thermistor circuits.—Fenwal Electronics, Inc., Mellen St., Framingham, Mass.
For more information circle **363** on inquiry card.

INDICATING CONTROLLER. 4-page brochure describes Type 541 Temperature Indicating Controller, housing styles, temperature ranges and switching mechanisms available.—Fenwal Inc., Pleasant St., Ashland, Mass.
For more information circle **364** on inquiry card.

TEMPERATURE CONTROLS. 8-page Condensed Catalog 400 covers local and remote-bulb units in general-purpose, explosion-proof, cailbrated and uncalibrated, fine-adjustment, wide-range and other types.—United Electric Controls Co., 85 School St., Watertown 72, Mass.
For more information circle **365** on inquiry card.

TEMPERATURE CONTROL. Sheet 500 describes Type E5 Model 4385A Tobacco Curing Temperature Control.—United Electric Controls Co., 79 School St., Watertown 72, Mass.
For more information circle **366** on inquiry card.

TEMPERATURE CONTROL. 4-page brochure describes and catalogs thermostats, thermoregulators, electronic relays, and accessories.—Philadelphia Scientific Glass Co., Paletown Rd., Quakertown, Penna.
For more information circle **367** on inquiry card.

BIMETAL THERMOSTATS. 2-page Bulletin 1000 describes principle, ratings, etc. or bimetal thermostats for appliances or for industrial applications.—Stevens Mfg. Co., Inc., P. O. Box 1007, Mansfield, Ohio
For more information circle **368** on inquiry card.

FLOW, PUMPS, LEVEL

FLOW METERING. 6-page Bulletin 100-R1 describes Propeloflo for liquids, and Shuntflo for air, steam

MERCOID
DIFFERENTIAL
PRESSURE
CONTROLS

Equipped with HERMETICALLY SEALED Mercury Contacts

TO "MAKE" OR "BREAK" AN ELECTRICAL CIRCUIT ON CHANGES IN THE DIFFERENCE BETWEEN TWO PRESSURES

FOR HIGH PRESSURES
Bourdon Tube Operated

Series BB: Operating ranges from 0-60 psi to 2,500 psi., with sensitivities varying from 0.4" to 50 psi.
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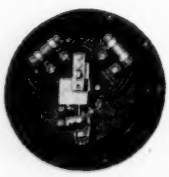

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Diaphragm Operated

Extremely sensitive, for air or gas. Series PQ: Operating ranges (inches of water) 6.0" vac. to 6.0" press. (sensitivity .03",) and 30.0" vac. to 30.0" press. (sensitivity 0.1" to 0.02").
Write for Bulletin No. 14

THE MERCOID CORPORATION
4201 Belmont Avenue, Chicago 41, Illinois

For more information circle **139** on inquiry card.

Comar's NEW

TYPE TJC FOR DC OPERATION VIDEO CONTACTS

Engineered specially for carrying video and other high frequency currents. Unusual flexibility of design permits a wide range of contact spring assemblies and combinations to be used. Fast operate, release and transfer time. Low interspring and spring-to-frame capacitance. Send for details.

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3349 ADDISON ST., CHICAGO 18, ILL.
RELAYS • SOLENOIDS • COILS • SWITCHES • HERMETIC SEALING

For more information circle **140** on inquiry card.

or gases with line drawings, cutaway views, and technical data tables.—Builders-Providence, Inc., 345 Harris Ave., Providence 1, R. I.

For more information circle **369** on inquiry card.

HIGH-VACUUM VAPOR PUMPS. 68-page Bulletin 6-1 contains much vacuum handbook data as well as descriptions of pumps and accessories.—Rochester Div., Consolidated Electrodynamics Corp., Rochester 3, N. Y.

For more information circle **370** on inquiry card.

LEVEL INSTRUMENTS. 20-page Form BD-15 describes diaphragm type bin level indicator; rotating-paddle type bin level indicator; and Bin-Flo Aerator, to promote flow of dry, finely ground bulk materials.—The Bin-Dicator Co., 13946 Kercheval Ave., Detroit 15, Mich.

For more information circle **371** on inquiry card.

CHEMICAL PUMP. 4-page Bulletin P-57-102 describes unique Randolph Pump featuring elimination of contact of moving parts with fluid being pumped.—Palo Laboratory Supplies Inc., 81 Reade St., New York 7, N. Y.

For more information circle **372** on inquiry card.

INDICATORS. 4-page Bulletin 18W describes three types of flow indicators for pipeline installation: flapper, rotary (paddle wheel), and ball; pressures and temperatures up to 250 psig and 500 F.—Dept. M-H, Schutte and Koerting Co., Cornwells Hts., Bucks County, Penna.

For more information circle **373** on inquiry card.

FLOW SWITCH. 2-page Bulletin I-FS4 contains information on flow switch to activate pumps, burners, alarms, etc.—McDonald & Miller, Inc., 3500 N. Spaulding Ave., Chicago 18, Ill.

For more information circle **374** on inquiry card.

BRONZE PUMPS. 4-page Catalog Section 109 describes line of 61 bronze positive-displacement pumps, capacities from 2 to 50 gpm; for pressures to 400 psi.—Department PR, Tuthill Pump Co., 939 E. 95th St., Chicago 19, Ill.

For more information circle **375** on inquiry card.

PRESSURE

PRECISION DIAL MANOMETER. 4-page Publication TP-30-A-5 describes a Secondary Standard instrument suitable for calibrating working gages, etc.—Wallace & Tiernan Inc., 25 Main St., Belleville 9, N. J.

For more information circle **376** on inquiry card.

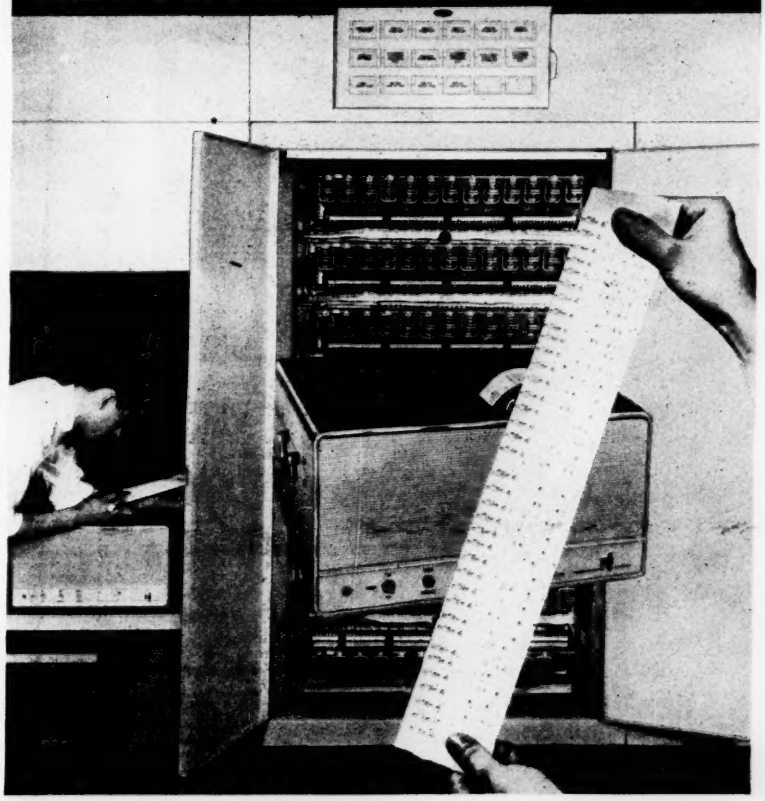
PRESSURE MEASUREMENT. 2-page Sheet 1163 describes DG-600 miniature Dynagage, an electronic instrument for measurement of static and dynamic pressures and displacements.—Photocon Research Products, 421 N. Altadena Dr., Pasadena, Calif.

For more information circle **377** on inquiry card.

PRESSURE AND FORCE PICKUPS. 2-page bulletin describes seven forms of Series 114 transducers incorporating Swiss-made SLM quartz crystal, special low-noise cable, and Piezo-Calibrator.—Kistler Instruments, 15 Webster St, North Tonawanda, N. Y.

For more information circle **378** on inquiry card.

OFF-NORMAL CONDITIONS REPORTED and RECORDED



NEW PANELLIT RECORDING ANNUNCIATOR UNCOVERS PROFIT LEAKS

- **Pinpoints temperature, flow, pressure and level process trouble areas by accurately, instantly recording off-normal operations.**
- **Permanent, unalterable statistical data helps prevent downtime repetition.**
- **No time-wasting decoding. Directly readable digital form.**

Typical power station application: The exact time period of steam stop valve closure, generator circuit breakers and overspeed trip resets is permanently recorded, providing advance notice of sluggish functioning and permitting immediate preventive action.

Model RA helps attain highest quality products by continuously monitoring all process variables. Also helps reduce downtime, maintenance and operating costs in your plant.

Write for Bulletin 102 today.

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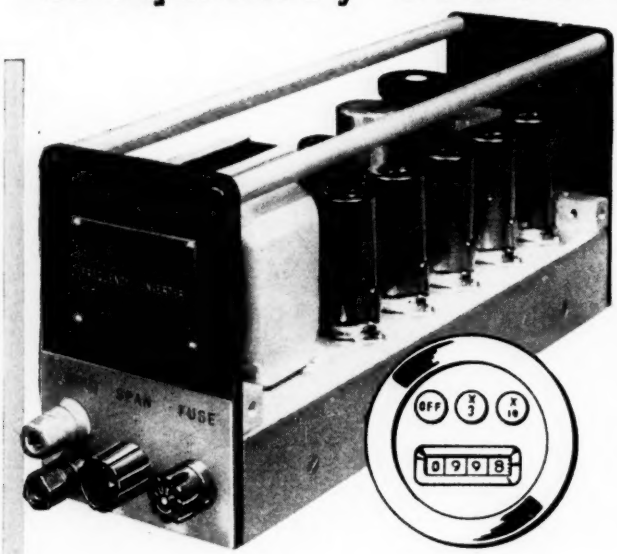
For more information circle **141** on inquiry card.

new cox frequency converter



The new Cox Frequency-to-Analog Converter joins the ever growing list of precision instruments designed and built for electronic data handling by the Cox Instruments Division — pioneers in precision flow measuring equipment.

The Type 2 Converter was originally developed for use with the Cox Turbine Flow Measuring System, but is now being widely used in many other applications for extremely linear conversions in telemetering, computers and other transducer-recorder systems. Its high sensitivity, excellent stability and fast transient response combined with low cost, make it an outstanding converter for all around use.

A new technical bulletin describing the Type 2 Frequency Converter is available upon request. Write to *Cox Instruments Division, George L. Nankervis Company, 15200 Fullerton Avenue, Detroit 27, Michigan.*

SPECIFICATIONS

Range	100 to 5000 cps (other ranges available)
Linearity	.1 per cent over 10:1 range
Stability	.1 per cent
Transient Response	1 millisecond
Price	$300 f.o.b. Detroit

cox instruments

Precision Instruments Since 1912

GLN-258

For more information circle **142** on inquiry card.

NEW LITERATURE

PRESSURE TRANSDUCERS, etc. Three 2-page Technical Bulletins—SI-581, SI-582, and SI-583 (in folder) describe (1) high-pressure, (2) medium-pressure transducers and (3) rectilinear potentiometers, all for airborne and rugged service applications.—Servonic Instruments, Inc., 640 Terminal Way, Costa Mesa, Calif.

For more information circle **379** on inquiry card.

BAROMETER, WIND SPEED. 2-page leaflet describes Wind Speed, Wind Direction and Barometric Pressure System.—Gardner Laboratory Inc., P. O. Box 5728, Bethesda 14, Md.

For more information circle **380** on inquiry card.

GAGE SAVER. 2-page bulletin lists specifications, features, installation and adjustment details.—Sprague Engineering Corp., 19300 So. Vermont Ave., Gardena, Calif.

For more information circle **381** on inquiry card.

TIME, SPEED, COUNT

VARIABLE SPEED DRIVE. 8-page Bulletin F-1882 describes Varitrol pneumatic system and U. S. Varidrive variable speed units.—U. S. Electrical Motors Inc., P. O. Box 2058, Terminal Annex, Los Angeles 54, Calif.

For more information circle **382** on inquiry card.

DIGITAL LOGGING CLOCK. 2-page Technical Bulletin No. 358-1 describes new digital clock for recording and indicating time of day.—Parabam, Inc. of El Segundo, Calif.

For more information circle **383** on inquiry card.

PHOTOELECTRIC TACHOMETER. 2-page bulletin describes DY-2504A designed for use with electronic counters for precise measurement of shaft rotational speeds; also to measure accumulated shaft rotation in turns or degrees from a start point, and to indicate shaft position.—Dynac, Inc., 395 Page Mill Rd., Palo Alto, Calif.

For more information circle **384** on inquiry card.

COUNTERS AND RATEMETERS. 4-page bulletin describes Digital Instruments for counting events, frequency, period and time interval measurements, in preset and control applications.—Hupp Instrumentation, Div. of Erie Pacific, 12932 S. Weber Way, Hawthorne, Calif.

For more information circle **385** on inquiry card.

ANALYTICAL, LABORATORY

OXYGEN TRACE ANALYZER. 2-page Bulletin 0-4114 describes the Model 80, a dual range instrument for continuous measurement of gas samples for minute quantities of oxygen, as low as 0 to 5 ppm.—Beckman/Process Instruments Div., 2500 Fullerton Rd., Fullerton, Calif.

For more information circle **386** on inquiry card.

COMBUSTIBLE-GAS INDICATORS. 16-page booklet describes proper method of selecting a particular instrument and the testing procedures recom-

mended.—Davis Emergency Equipment Co., Inc., 45 Halleck St., Newark 4, N. J.

For more information circle **387** on inquiry card.

INFRARED INSTRUMENT. 24-page brochure describes Infracord, a double-beam infrared spectrophotometer. —Instrument Div., Perkin-Elmer Corp., Main Ave., Norwalk, Conn.

For more information circle **388** on inquiry card.

LAB EQUIPMENT. 16-page May 1958 issue of Lab-ORATORY features chromatographic equipment, improved Fraction Collector with Totalizer-Multipler attachment, magnetic stirring bars; Impelator, new hydraulic laboratory press with thermostatic control in one or both platens; etc. —Schaar and Co., 7300 W. Montrose Ave., Chicago 34, Ill.

For more information circle **389** on inquiry card.

LAB GLASSWARE. 12-page pocket-size Bulletin 851 on Diamond D Blue Line of laboratory glassware pictures the most important items in this line. —Doerr Glass Company, Vineland, N. J.

For more information circle **390** on inquiry card.

RECORDING MICROPHOTOMETERS. Announcement of a versatile laboratory analyzer which with an ElectroniK recorder, enables continuous investigation of wide range of film patterns.—Wihtol Industries, Lewis St., Eatontown, N. J.

For more information circle **391** on inquiry card.

SPECTROCHEMICAL ANALYZER. 4-page bulletin describes Quantrol, an x-ray fluorescence instrument designed for continuous stream monitoring of solids, liquids or powders, directly on the production line.—Applied Research Labs., Inc., P. O. Box 1710, Glendale 5, Calif.

For more information circle **392** on inquiry card.

LABORATORY GRINDER. 2-page Bulletin No. 2297 describes Aminco-Chatten laboratory grinder, designed to prepare laboratory test specimens of flexible materials such as leather, rubber, linoleum, etc.—American Instrument Co., 8030 Georgia Ave., Silver Spring, Md.

For more information circle **393** on inquiry card.

FLAME PHOTOMETER Model 21 described in 6-page Bulletin B-242, is designed for rapid, precise determination of Sodium, Potassium and Calcium.—Coleman Instruments Co., 318 W. Madison St., Maywood, Ill.

For more information circle **394** on inquiry card.

GAS CHROMATOGRAPHY. 2-page Bulletins RF 17A and RF119 contain technical data, illustrations, on apparatus for trace analysis by gas chromatography and for analysis of high-boiling-compounds by gas chromatography.—F & M Scientific Glassware Co., 1001 Kendall Rd., Wilmington 5, Del.

For more information circle **395** on inquiry card.

SPECIALIZED LAB INSTRUMENTS. 10-page 1958 Catalog describes refrigerated, and enclosed and automatic superspeed centrifuges, ultra-microtomes, high-speed homogenizers, automatic pipettes, magnetic stirrers, high-precision conductivity bridge, fraction collector, electrophoresis and chromatography equipment, gas and moisture testers, etc.—Ivan Sorvall Inc., Pearl St., Norwalk, Conn.

For more information circle **396** on inquiry card.

NUCLEONICS

"HOT" LAB INSTRUMENTS. 20-page Catalog D-287 describes and illustrates Remote Control Stereomicroscope and Remote Control Metallograph.—Bausch & Lomb Optical Co., Industrial Instrument Sales, 898 St. Paul St., Rochester 2, N. Y.

For more information circle **397** on inquiry card.

SAFETY TONGS. 2-page Bulletin No. N-200 describes Griptongs and Niptongs that protect technicians when handling radioactive objects or removing small objects from furnaces, ovens and acid baths.—Palo Laboratory Supplies, Inc., 81 Reade St., New York 7, N. Y.

For more information circle **398** on inquiry card.

CONTROL COMPONENTS AND SYSTEMS for nuclear reactors are described in 4-page Bulletin GR-57-6.—General Regulator Corp., 666 Fifth Ave., New York 19, N. Y.

For more information circle **399** on inquiry card.

RADIATION MEASUREMENTS. 8-page No. 16 of The Nucleus describes new Dynacom electrometer, complete system for measuring C-14, H-3, S-35 and other beta emitters in gases, liquids and solids.—Nuclear-Chicago Corp., 223 W. Erie St., Chicago 10, Ill.

For more information circle **400** on inquiry card.

PARTICLE ACCELERATORS. 12-page Bulletin B describes applications of both Van de Graaff and linear accelerators, utilizing photographs and line drawings to point up significant design and performance features.—High Voltage Engineering Corp., Burlington, Mass.

For more information circle **401** on inquiry card.

NUCLEAR SAFETY EQUIPMENT. 8-page Technical Bulletin N-35 describes shielded isotope storage containers, lead shields, lead glass and steel bricks, timers, remote handling tongs and pipesetters, laboratory carts, etc. —Nucleonic Corp. of America, 196 Degraw St., Brooklyn 31, N. Y.

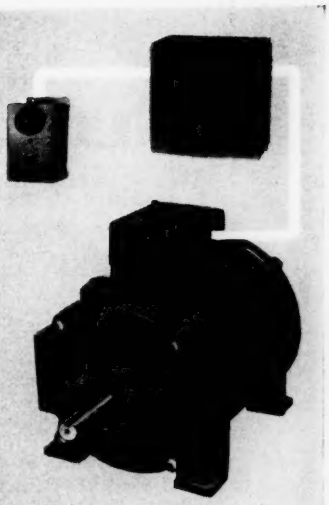
For more information circle **402** on inquiry card.

ION ACCELERATORS. 6-page technical bulletin describes Cockcroft-Walton positive ion accelerators; includes graphs showing neutron yields and energies, discussion of applications for chemical analysis, nuclear chemistry, physics and nuclear engineering.—Applied Radiation Corp., Walnut Creek, Calif.

For more information circle **403** on inquiry card.

RADIATION DETECTION EQUIPMENT. 2-page Bulletin PCC-58 describes three models of a new proportional counter converter for detecting radioactivity in prepared samples. Measures alpha, beta and gamma radiation.—Nuclear Measurements Corp., 2460 N. Arlington Ave., Indianapolis 18, Ind.

For more information circle **404** on inquiry card.



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ADJUSTABLE-SPEED DRIVES

- **SPEED RANGE** Infinitely adjustable from less than 36 rpm to more than 3600 rpm while delivering full rated torque. Continuous duty rating at all speeds.
- **REGULATION** Both line and load regulation is better than ½ of 1% of rated speed.
- **HORSEPOWER** Various models from ¾ hp down to 1/200 hp. Motors of ¼ hp and larger are totally enclosed.
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- **MAINTENANCE** Fully encapsulated construction results in long service life. Plug-in construction requires only a screwdriver for servicing.
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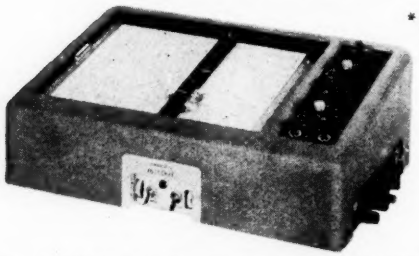
For more information circle **143** on inquiry card.

THE MOSELEY

AUTOGRAF trade mark

X-Y-Ⓣ* RECORDER

* with TIME BASE



Model 3 S

A new innovation in X-Y Recorders incorporating on the X-axis a TIME BASE or SWEEP CIRCUIT which may be used in numerous applications requiring the plotting of one variable against time. Standard two-variable plotting capability, when desired, is not impaired.

FEATURES

- 5 calibrated time intervals at 5, 10, 50, 100, and 500 seconds for full scale pen travel on X-axis.
- 11 input ranges from 5 millivolts to 500 volts on each axis.
- One-half second full scale recording speed.
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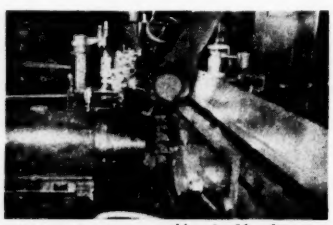
HASLER SPEED INDICATOR

Chronometric Tachometer with Separate Reset Button for Cumulative Readings.



Accurate: Average ¼ of 1% of true speed through life

Automatic
Durable
Non-Magnetic
Weight, 7¾ oz.

Type A 0—20,000 R.P.M.
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Shipment within five days from stock

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For more information circle **145** on inquiry card.

FREED
VARIABLE TEST VOLTAGE MEGOHMMETER NO. 1620

The Freed Type 1620 Megohmmeter is a versatile insulation resistance measurement instrument with a continuously variable DC test potential from 50 to 1000 volts.

Components such as transformers, motors, printed circuits, cables and insulation material can be tested at their rated voltage and above, for safety factor.

- **Resistance** — 0.1 megohms to 4,000,000 megohms.
- **Voltage** — variable, 50 - 1000 volts.
- **Accurate** — plus or minus 5% on all ranges.
- **Simple** — for use by unskilled operators.
- **Safe** — high voltage relay controlled.
- **Self contained** — AC operated.

OTHER MEGOHMMETERS AVAILABLE

Type 1620C MEGOHMMETER — a type 1620 with additional circuitry for testing capacitors.
Type 1020B MEGOHMMETER — a 500 volt fixed test potential. Range 1 megohm to 2 million megohms.
Type 2030 PORTABLE MEGOHMMETER — battery operated 500 volt test potential. Range 1 megohm to 10 million megohms.

Send for NEW 48 page transformer catalog. Also ask for complete laboratory test instrument catalog.

FREED TRANSFORMER CO., INC.
1717 WEIRFIELD ST., BROOKLYN (RIDGEWOOD) 27, N.Y.

For more information circle **146** on inquiry card.

NEW LITERATURE

RADIATION DETECTION INSTRUMENTS. 4-page, April 1958 issue of "The NMC Fallout" contains articles on three of the newest radiation detection instruments.—Nuclear Measurements Corp., 2460 N. Arlington Ave., Indianapolis 18, Ind.
For more information circle **405** on inquiry card.

DATA HANDLING

DIGITAL INFORMATION SYSTEM. 8-page Bulletin E72-1 describes data-gathering equipment.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio
For more information circle **406** on inquiry card.

SIMPLIFIED COMPUTER METHOD. 4-page bulletin describes the unusual features of a new Intercom 1000, designed for use with maker's G-15 general-purpose digital computer, which greatly simplifies process of writing instructions to a computer.—Bendix Computer Div., 5630 Arbor Vitae St., Los Angeles 45, Calif.
For more information circle **407** on inquiry card.

DATA PROCESSING. 4-page Bulletin 3014 describes Model 123 Data Processing System which is a standard, 100-channel data logger, featuring pin-board programming and all solid state construction, for process plants, power plants, pilot operations, etc.—Beckman/Systems Div., 325 N. Muller Ave., Anaheim, Calif.
For more information circle **408** on inquiry card.

COMPUTER PROGRAMMING. 4-page brochure titled "Introducing a New Language for Automatic Programming" discusses new Flow-Matic System for Univac.—Remington Rand Univac, Div. of Sperry Rand Corp., 315 Fourth Ave., New York 10, N. Y.
For more information circle **409** on inquiry card.

DIGITAL INDICATOR. 6-page Catalog 51-1800, containing 3 illustration sheets, describes precision in-line Digital Indicator, which accepts a variable frequency a-c input and converts it to a 5-digit indication, accurate to within 1 frequency count.—Fischer & Porter Co., 627 Jacksonville Rd., Hatboro, Penna.
For more information circle **410** on inquiry card.

DATA PROCESSOR. Literature package comprises 4-page Bulletin Form 463 and 5 data sheets on desk-top machine.—Taller & Cooper, Inc., Div. of American Electronics, Inc., 75 Front St., Brooklyn 1, N. Y.
For more information circle **411** on inquiry card.

MEMORY UNIT. 2-page bulletin announces Model 603-A for automatic control systems comprising 60 capacitors mounted on a wheel with charging and pickoff brushes.—Industrial Control Co., 805 Albin Ave., Lindenhurst, L. I., N. Y.
For more information circle **412** on inquiry card.

DIGITAL BUILDING BLOCKS. 4-page brochure describes Digitrol units including amplifiers, multipliers, actuators, converters, gates, servos, etc.—Electro Precision Corp., Application Engineering Dept., P. O. Box 669, Arkadelphia, Arkansas
For more information circle **413** on inquiry card.

MAGNETIC-TAPE RECORDERS. Magneloop series of continuous-loop magnetic tape recorders-reproducers incorporating an unusual tape drive are described in 4-page folder.—Amplifier Corp., of America, 398 Broadway, New York 13, N. Y.

For more information circle **414** on inquiry card.

IN-LINE READOUT. 4-page bulletin features new readout and describes frequency-period counters, time-interval meters, and digital printer.—Computer-Measurements Corp., 5528 Vineland Ave., No. Hollywood, Calif.

For more information circle **415** on inquiry card.

TRANSISTORIZED A/D CONVERTER. 2-page Technical Bulletin 50DC1000 gives specs of a/d converter.—Fischer & Porter Co., 790 Jacksonville Rd., Hatboro, Penna.

For more information circle **416** on inquiry card.

RECORDING HEADS. 2-page bulletin describes and specifies precision magnetic recording heads, Type RH 1615.—Applied Magnetics Corp., P. O. Box 425, Santa Barbara Airport, Goleta, Calif.

For more information circle **417** on inquiry card.

RATIO SYSTEMS. 4-page Product Bulletin 101 describes automatic digital systems that determine the ratio between two input parameters, such as pressure, force, acceleration, displacement, and temperature.—Wiancko Engineering Co., 255 N. Halstead Ave., Pasadena, Calif.

For more information circle **418** on inquiry card.

SEND-RECEIVE SET. 16-page bulletin describes message unit which will function both "off" line locally or "on" line over communication channels.—Teletype Corp., Dept. SP-1, 4100 Fullerton, Chicago 39, Ill.

For more information circle **419** on inquiry card.

RECORDERS

RECEIVER RECORDER & CONTROLLER. 16-page Product Specification E12-5 describes newly developed plug-in components for maker's recorder: twelve types of receivers, controllers, retransmitters, and direct measuring devices from which recorder can be custom-built.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio

For more information circle **420** on inquiry card.

STRIP-CHART RECORDER. 4-page Data Sheet G-11A gives description and features of small-size moderate-cost strip-chart recorder of the null-balance potentiometer type.—Varian Associates, Instrument Div., 611 Hansen Way, Palo Alto, Calif.

For more information circle **421** on inquiry card.

MONITORS

RECORDING ANNUNCIATOR. 4-page Bulletin 102 describes new Recording Annunciator which prints a tape record.—Panalarm Div., Panellit, Inc., 7401 N. Hamlin Ave., Skokie, Ill.

For more information circle **422** on inquiry card.

ANNUNCIATOR. 4-page Bulletin 101 describes a new static-magnetic annunciator for monitoring complex automatic machine and continuous process operations.—Panellit, Inc., 7401 N. Hamlin Ave., Skokie, Ill.

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Therma Bridge

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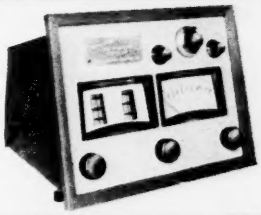

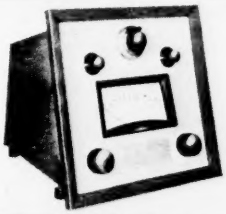

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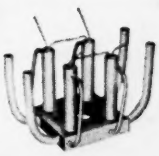

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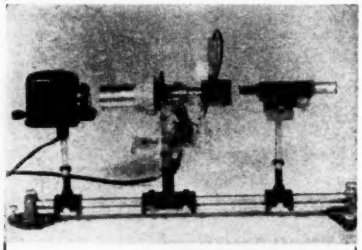

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For more information circle **148** on inquiry card.

NEW LITERATURE

PILOT LIGHTS. 16-page Form L-161 is a digest of condensed technical information on a wide range of Dialco Pilot Light Assemblies and the appropriate lamp types housed therein. —Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y.
For more information circle **424** on inquiry card.

SIGNAL LIGHT SOURCES. 4-page Bulletin 30.30 describes Isolite units consisting of radiation responsive phosphor crystals, enclosed in a hermetically-sealed transparent capsule and excited to luminescence by radioactive Kr^{85} gas.—United States Radium Corp., Morristown, N. J.
For more information circle **425** on inquiry card.

INDICATOR LIGHT. Data sheet illustrates and describes Type No. 50 indicator light assembly for use with standard miniature bayonet T3¼ lamp.—Drake Manufacturing Co., 1711 W. Hubbard St., Chicago 22, Ill.
For more information circle **426** on inquiry card.

MOTOR SPEED CONTROL. 4-page Bulletin 558-1, titled "How to Maintain Constant Motor Speed," describes the new line of Fincor a-c and d-c motor controls using static magnetic amplification to maintain desired motor speed regardless of load variations.—Fidelity Instrument Corp., 1000 E. Boundary Ave., York, Penna.
For more information circle **427** on inquiry card.

TESTING, GAGING, INSPECTING

CALIBRATING MACHINE. 4-page Bulletin 158 describes proving-ring type machine which facilitates the calibration of load cells; discusses application, operation and specs.—Morehouse Machine Co., 1742 Sixth Ave., York, Penna.
For more information circle **428** on inquiry card.

PROVING RINGS. 4-page Bulletin 159 contains general and dimensional specifications for compression and compression-tension-type proving rings. —Morehouse Machine Co., 1742 Sixth Ave., York, Penna.
For more information circle **429** on inquiry card.

TEST TABLES for tilt, translation, turn and Scorsby are covered in 2-page catalog sheet KT.—Kearfott Co., Inc., 1378 Main Ave., Clifton, N. J.
For more information circle **430** on inquiry card.

DIAL INDICATORS. 12-page catalog "D" describes and illustrates complete "Em-re" line covering all four A.G.D. groups, also "Golden Em-re" Dial Indicators, Service Kits for A.G.D. Group 2 dial indicators, and "Master" Dial Indicator Checker.—Petz-Emery, Inc., Pleasant Valley, N. Y.
For more information circle **431** on inquiry card.

HARDNESS TESTER. 2-page Data Sheet TT-58 describes new combination Rockwell and Rockwell Superficial hardness tester.—Wilson Mechanical Instrument Div., American Chain & Cable Co., Inc., 230 Park Ave., New York 17, N. Y.
For more information circle **432** on inquiry card.

DIODE TESTER. 2-page bulletin describes Model DT-257 tester for production runs.—Teletronics Lab., Inc., 54 Kinkel St., Westbury, L. I., N. Y.
For more information circle **433** on inquiry card.

BORESCOPES. 12-page pocket-size folder illustrates and describes three most commonly used Lenox interchangeable viewing heads.—Lenox Instrument Co., 2012 Chancellor St., Phila. 3, Pa.
For more information circle **434** on inquiry card.

CONSOLIDATION TESTS. 2-page folder describes Levermatic table-top 20-ton-capacity consolidation machine.—Soiltest, Inc., 4711 W. North Ave., Chicago 39, Ill.
For more information circle **435** on inquiry card.

PENETRANT INSPECTION. 4-page bulletin illustrates and describes dye penetrant inspection materials, available in nonflammable or very-high-flash-point formulas in pressure-spray cans.—Magnaflux Corp., 7300 W. Lawrence Ave., Chicago 31, Ill.
For more information circle **436** on inquiry card.

TUBING, FITTINGS

VACUUM-JACKETED LINES for transfer of low-temperature liquid oxidizers are described in 12-page Bulletin 4-80.—Rochester Div., Consolidated Electrodynamics Corp., 1775 Mt. Read Blvd., Rochester 3, N. Y.
For more information circle **437** on inquiry card.

SOCKET-WELD FITTINGS. 4-page Bulletin SW 358 describes a complete new line of low-cost stainless socket-weld fittings (made in tube O. D. sizes).—The Special Screw Products Co., Bedford, Ohio.
For more information circle **438** on inquiry card.

FLEXIBLE METAL HOSE. 36-page catalog covers numerous sizes and types of Penflex, also couplings, flanges and other fittings, special assemblies, etc., as well as engineering data.—Pennsylvania Flexible Metallic Tubing Co., Inc., 7200 Powers Lane, Phila., Pa.
For more information circle **439** on inquiry card.

TUBING FLARER. Catalog sheets 1145 A13 and 1145A14 describe a new improved squaring and burring attachment for Model 232 power tube flarer. —Parker Fittings & Hose Div., Parker-Hannifin Corp., 17325 Euclid Ave., Cleveland 12, Ohio.
For more information circle **440** on inquiry card.

CABLED TUBES. 12-page Bulletin 458 titled "Crescent Armored Multitube" gives information on cabled tubes for instruments and controls.—Crescent Insulated Wire & Cable Co., Inc., P. O. Box 850, Trenton 5, N. J.
For more information circle **441** on inquiry card.

DISCONNECT COUPLINGS. 26-page General Catalog describes standard line of quick-connect, quick-disconnect couplings.—Snap-Tite, Inc., Union City, Penna.
For more information circle **442** on inquiry card.

TUBE FITTINGS. 20-page Catalog 058 covers straight-thread hydraulic tube fittings.—Flodar Corp., 16911 St. Clair Ave., Cleveland 10, Ohio.
For more information circle **443** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

VOLTAGE REGULATOR. 2-page bulletin describes new Stabiline Type EMT 4104 U transistorized electromechanical automatic VR featuring zero waveform distortion and virtually zero phase shift.—The Superior Electric Co., 83 Laurel St., Bristol, Conn.
For more information circle **444** on inquiry card.

D-C VOLTMETERS. 2-page preliminary data sheet provides information and specifications on Model 1145 expanded scale d-c voltmeters.—International Instruments Inc., P. O. Box 2954, New Haven 15, Conn.
For more information circle **445** on inquiry card.

AMPLIFIERS. Two mutually complementary 2-page bulletins describe: (1) electronic amplifier and power supply which together control, (2) mechanical power amplifier providing variable torque-speed characteristics for high-performance servo systems.—Seneca Falls Machine Co., Electronics Div., Seneca Falls, N. Y.
For more information circle **446** on inquiry card.

PIPE LOCATOR. Announcement of new Model 162 transistor pipe locator and metal detector with maximum range of 21 feet.—Gardiner Electronics Co., 2545 E. Indian School Rd., Phoenix, Arizona.
For more information circle **447** on inquiry card.

SELENIUM RECTIFIERS. 8-page booklet gives complete descriptions, data and specifications for rectifier plates and stacks; and cartridge-type rectifiers and stacks.—Syntron Co., 702 Lexington Ave., Homer City, Penna.
For more information circle **448** on inquiry card.

ELECTRONIC INSTRUMENTS. 56-page 1958-59 Catalog contains a great deal of technical information as well as descriptions of oscillators, pulse & pulsed carrier generators, sound & vibration analyzers, etc.—Kay Electric Co., Maple Ave., Pine Brook, N. J.
For more information circle **449** on inquiry card.

DIFFERENTIAL MILLIVOLTMETER. 2-page bulletin describes new Type MV-37A Differential Input DC Millivolt which measures 100 microvolts to kv and has symmetrical high-impedance input circuits.—Millivac Instruments, P. O. Box 997, Schenectady, N. Y.
For more information circle **450** on inquiry card.

VTVM. 4-page bulletin describes Type MV-57A precision dc vacuum-tube voltmeter and dc calibrator combining a standard VTVM, a highly accurate (0.25%) voltmeter comparator and a source of calibration on signals.—Millivac Instruments, P. O. Box 997, Schenectady, N. Y.
For more information circle **451** on inquiry card.

VOLTAGE TO FREQUENCY CONVERTER. 2-page bulletin describes Model DY-2210 which permits accurate voltage measurements with standard electronic counters; featuring multiple input ranges, either polarity; output frequency zero to 10,000 cps.—Dynac, Inc., 395 Page Mill Rd., Palo Alto, Calif.
For more information circle **452** on inquiry card.

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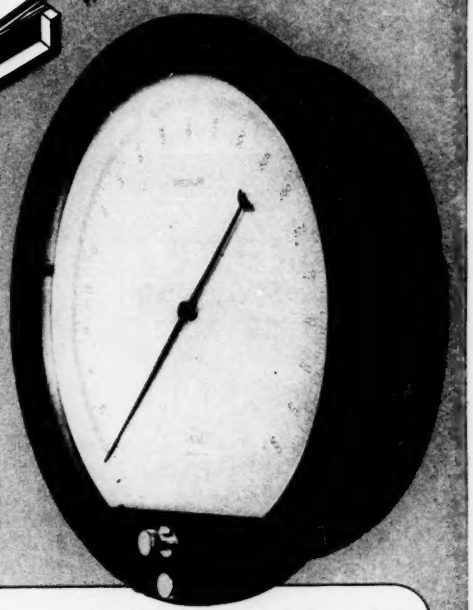

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For more information circle **149** on inquiry card.

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BALLOON
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require MAXIMUM Performance
MINIMUM Size - Weight - Power Drain

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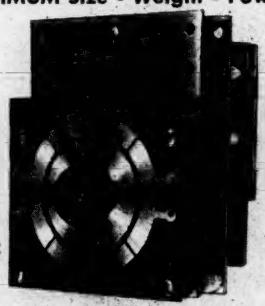

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Size—1¾" x 2¼"—depth depends on number of decks
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Special commutators to order for a nominal tool charge.
Shorting or non-shorting contact • Power input—.008 Amp. at 6 VDC

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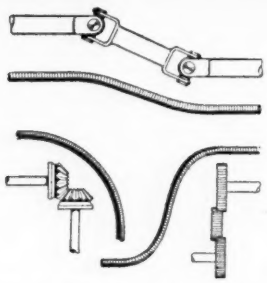

Flexible Shafting reduces the noisy and cumbrous gearing used in conjunction with solid shafts. It has the ability to transfer power from remote places, over, under, and around obstacles found in the path of installation between the drive and the driven units. Flexible Shafting requires very few parts, making them inexpensive; whereas solid shafts using universal joints, miter gears, and gear trains, many times would not be feasible because of their noisiness or lack of economy. With a Flexible Shaft assembly, design may be simplified and your engineering time spent on other necessary component parts without having to worry that they will create obstacles when placed where you want them.

Flexible Shafting cuts down on vibration thus offering long life with very little maintenance required. For complete Flexible Shaft information, write F. W. Stewart Corporation, 4311 Ravenswood Ave., Chicago 13, Illinois.

For more information circle **151** on inquiry card.

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ELECTRONIC TESTING INSTRUMENTS. Nine 2-page bulletins describe Model 10A a-c electronic voltmeter, Model 11A DBM/DBA meter, Model 14A True-RMS a-c voltmeter, Model 15A multi-range a-c voltmeter, Model 20A test oscillator, Model 21A push button test oscillator, Model 25A telecommunication test oscillator, Model 40A push button attenuator, and Model 41A push button balanced attenuator.—Alectra Div., CEC, 325 N. Altadena Dr., Pasadena, Calif.

For more information circle **453** on inquiry card.

TUBES

RADIO AND TV TUBES. Suggested retail prices of electron tubes for radio and TV are given on 11" x 14" wall chart covering 839 tubes.—Tung-Sol Electric Inc., 95 Eighth Ave., Newark 4, N. J.

For more information circle **454** on inquiry card.

CATHODE RAY TUBES. Folder contains twelve 2-page data sheets giving applications, characteristics, and general information on cathode ray tubes.—Waterman Products Co., Inc., Dept. L-41, 2445 Emerald St., Phila. 25, Pa.

For more information circle **455** on inquiry card.

MAGNETICS

CERAMIC GRATE MAGNET. 2-page Bulletin 1072 describes new Indox Grate Magnet for tramp-iron removal; wing-type for floor opening or hopper installation, and drawer-type for chutes and ducts.—Stearns Magnetic Products, 635 South 28th St., Milwaukee 46, Wisc.

For more information circle **456** on inquiry card.

MAGNETIC AMPLIFIER. 2-page bulletin describes Model 430 integrating magnetic amplifier which operates from any standard 115 volt, 400 cps power supply and requires less than 3 watts. Unit is completely self-contained, plug-in type.—Acromag, Inc., 22519 Telegraph Rd., Detroit 41, Mich.

For more information circle **457** on inquiry card.

SWITCHES, RELAYS

AUTOMATIC TRANSFER SWITCHES. 24-page Publication 596R1 discusses "Factors to Consider in the Selection and Application of Automatic Transfer Switches."—Automatic Switch Co., Hanover Rd., Florham Park, N. J.

For more information circle **458** on inquiry card.

CALIBRATION SERVICES for flow rate are described in 6-page folder.—Cox Instruments Div., George L. Nankervis Co., 15300 Fullerton Ave., Detroit 27, Mich.

For more information circle **459** on inquiry card.

LIMIT SWITCHES. 2-page Data Sheet 122 describes a new series of hermetically-sealed limit switches for use between −65°F and 600°F.—Micro Switch, Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

For more information circle **460** on inquiry card.

INERTIA AND IMPACT SWITCHES. 4-page catalog describes new switches featuring new operating principle, only one moving part, operation in any plane, and adjustable G level over Wide Range.—Inertia Switch Div., Safe Lighting, Inc., 527 Lexington Ave., New York 17, N. Y.

For more information circle **461** on inquiry card.

GLASS MERCURY SWITCHES. 8-page bulletin describes mercury switch hermetically sealed with atmosphere of purest hydrogen.—Gordos Corp., 250 Glenwood Ave., Bloomfield, N. J.
For more information circle **462** on inquiry card.

RELAYS. 4-page Brochure 58-3 features 132 stock relays, including subminiature sensitive, power, antenna, telephone, and hermetically sealed types. Cross-reference relay chart S200-A also available.—Kurman Electric Co., Div. of Norbute Corp., 191 Newel St., Brooklyn 22, N. Y.
For more information circle **463** on inquiry card.

HI-VOLTAGE SWITCH. 2-page Bulletin 158-HV gives performance data and environmental conditions of Type C-80335-001 hermetically-sealed, high-voltage rotary selector switch, rated at 1650 vdc and 20 Ma.—G. H. Leland, Inc., 123 Webster St., Dayton 2, Ohio
For more information circle **464** on inquiry card.

QUICK-CONNECT SWITCH. 2-page Data Sheet 14b describes a quick connect ultra-small switch, high in electrical capacity.—Micro Switch, a Division of Minneapolis-Honeywell Regulator Co., Freeport, Ill.
For more information circle **465** on inquiry card.

RESISTORS, POTENTIOMETERS

HIGH-RELIABILITY RESISTORS. 20-page brochure, entitled "Factual Resistor Reliability," describes non-destructive conditioning and testing procedures used on high-reliability precision resistors; includes complete test specifications ME3 and ME4.—Mepco Inc., Morristown, N. J.
For more information circle **466** on inquiry card.

PRECISION POTENTIOMETERS. 10-page Catalog P103 describes single and multi-turn pots with both linear and non-linear characteristics.—Analogue Controls, Inc., 39 Roselle St., Mineola, N. Y.
For more information circle **467** on inquiry card.

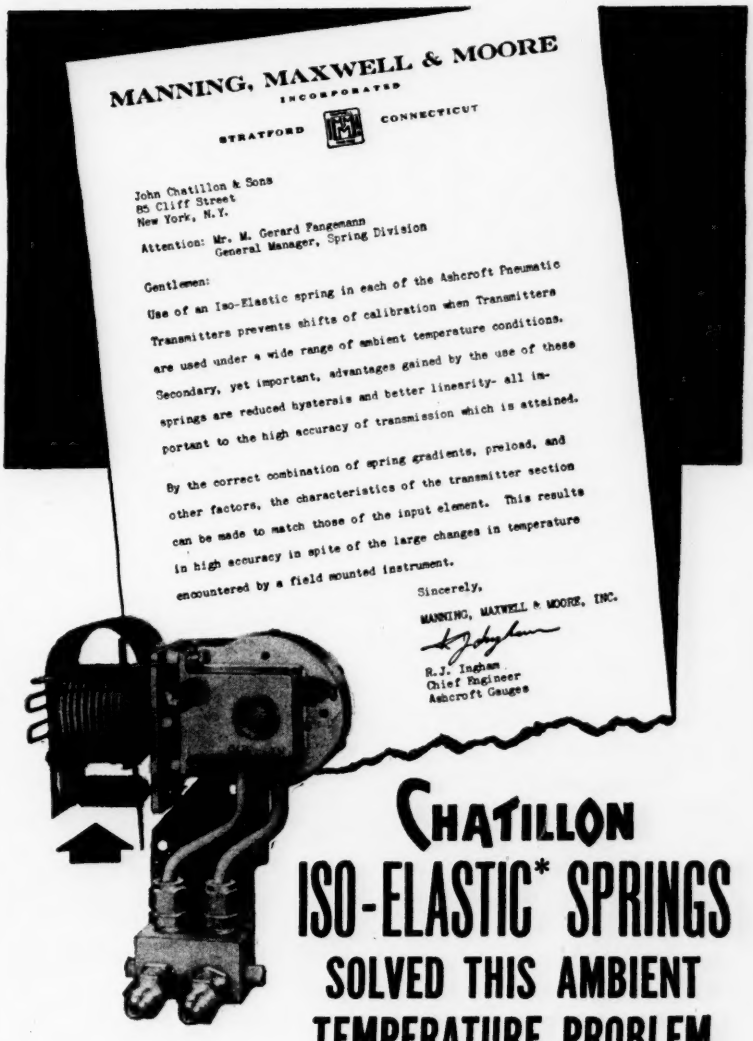
RHEOSTATS. 2-page bulletin announces Mikrohm Series 310 low-resistance rheostats with infinitely-fine adjustments, excellent resolution and resettability.—The Superior Electric Co., 83 Laurel St., Bristol, Conn.
For more information circle **468** on inquiry card.

POWER SUPPLIES

POWER SUPPLIES. 2-page technical data sheet describes Magnetic Rangers, Models MR36-15 and MR36-30, tubeless continuously-variable regulated 5-36 VDC power supplies with outputs of 0-15 and 0-30 amps, respectively.—Sorensen & Co., Inc., Richards Ave., S. Norwalk, Conn.
For more information circle **469** on inquiry card.

TRANSISTORIZED POWER SUPPLY. "How To Build a Transistorized 40-Watt Supply" is title of 6-page Bulletin E-279.—CBS-Hytron, Danvers, Mass.
For more information circle **470** on inquiry card.

MAGNETIC VOLTAGE REGULATORS. 8-page Bulletin S358TM describes 1 and 5KVA Stabiline type TM tubeless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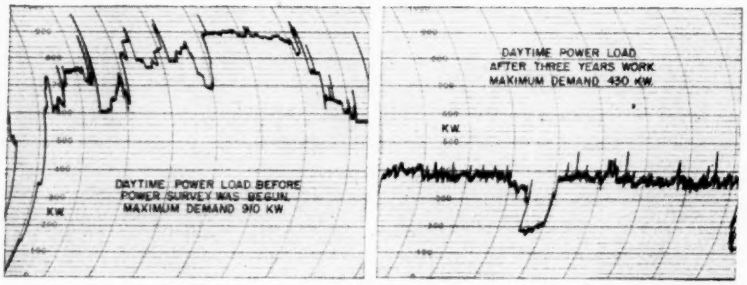
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NEW LITERATURE

magnetic automatic voltage regulators.—The Superior Electric Co., 83 Laurel St., Bristol, Conn.
For more information circle **471** on inquiry card.

DC POWER SOURCES, regulated to less than 0.05%, Types A and B also 0.01% computer power source, Model D305-CS, and transistorized Model 3206 are described in 4-page Catalog 58.—Power Designs Inc., 89-25 130th St., Richmond Hill 18, N. Y.
For more information circle **472** on inquiry card.

VOLTAGE REGULATORS. 2-page catalog sheet illustrates and specifies Series 1.050 Precision Filament voltage regulators.—Electric Regulator Corp., Pearl St., Norwalk, Conn.
For more information circle **473** on inquiry card.

SILVER-ZINC BATTERIES. 8-page bulletin "New Automatic Activation Makes Yardney Primary and Secondary Batteries Interchangeable" describes new split-second activating method.—Yardney Electric Corp. 40-50 Leonard St., New York 13, N. Y.
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ELECTRICAL ELECTRONIC COMPONENTS

VOLTAGE DIVIDERS. Several 2-page spec sheets describe various new models of Micropots.—Borg Equipment Div., The George W. Borg Corp., 120 S. Main St., Janesville, Wisc.
For more information circle **475** on inquiry card.

DELAY LINES. 2-page Data Sheet 105 lists over a dozen of Custom Built units with delays from 0.1 to 36 usec, and over 90 Distributed Constant units with standard impedances and delays.—Control Electronics 1925 New York Ave., Huntington Station, L. I., N. Y.
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DELAY LINES. 20-page catalog describes mercury and quartz delay lines including precision range markers and lock test lines.—Laboratory for Electronics, Inc., 75 Pitts St., Boston, Mass.
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SILICON DIODE PACKAGES. Four 2-page Bulletins describe: Single, 20-amp, 4-diode, and multiple-diode package.—Master Specialties Co., 956 E. 108th St., Los Angeles 59, Calif.
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TANTALUM CAPACITORS. 4-page Bulletin 6.100-3 describes "PP" Type Capacitor comprising a sintered porous tantalum anode hermetically sealed into an uninsulated fine silver case which serves both as cathode and container for the electrolyte.—Fansteel Metallurgical Corp., Rectifier-Capacitor Div., 2200 Sheridan Rd., North Chicago, Ill.
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COMPONENTS. 32-page catalog, imprinted "Largest Stock of Relays in the World," covers many types of relays; also switches, counters, solenoids, voltage regulators, choppers, filters, magnetic brakes, steppers,

timers and thermal-delay devices, contactors, resistors, etc.—Universal Relay Corp., 42 White St., New York 13, N. Y.

For more information circle **480** on inquiry card.

CAPACITORS. 4-page Issue No. 1 of "Kemet Electronics Products Engineering Bulletin" details characteristics and applications of solid tantalum capacitors.—Kemet Co. Div. of Union Carbide Corp., Madison Ave. and W. 117th St., Cleveland, Ohio.

For more information circle **481** on inquiry card.

MICROWAVE COMPONENTS. Folder contains 4 brochures offering both mechanical and electrical characteristics of waveguide twists e & h plane 90° elbows, adapters, and couplers.—Aircom Inc., 139 East First Ave., Roselle, N. J.

For more information circle **482** on inquiry card.

TRANSDUCER. 2-page leaflet gives specs for Magacycler, a precision frequency- and pulse-rate transducer using only static elements to produce a d-c output current or voltage directly proportional to the input frequency.—Pioneer Magnetics Inc., 5858 Wilshire Blvd., Los Angeles 36, Calif.

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CONNECTORS

CONNECTORS. 8-page Bulletin EX-1 describes new "EX" electrical connectors for high-altitude, high-vibration applications.—Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif.

For more information circle **484** on inquiry card.

CONNECTORS. 16-page Catalog MS-E-3 covers lighter, shorter "Series CT" plug which meets all military requirements for Type "E" environmental-resistant connectors.—Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif.

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MECHANICAL, ELECTROMECHANICAL COMPONENTS

INSTRUMENT COMPONENT KITS. 16-page pocket size Catalog 17 describes precision instrument component kits.—PIC Design Corp., Sub. of Benrus Watch Co., Inc., 477 Atlantic Ave., East Rockaway, L. I., N. Y.

For more information circle **486** on inquiry card.

TOOLS. 32-page Catalog 16 lists over 300 different tool components, such as clamps, studs, thumb screws, swing washers, round shafting, etc.—PIC Design Corp., Sub. of Benrus Watch Co., Inc., 477 Atlantic Ave., E. Rockaway, L. I., N. Y.

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ELECTRONIC HARDWARE. 24-page Catalog 30 contains dimensional drawings of available insulated terminals, standard turret terminals, stand-offs, handles, quintlock nuts; also terminal boards and tooling.—Lerco Electronics, Inc., 501 South Varney St., Burbank, Calif.

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Adage, Inc. 1426
American Chain & Cable Co., Inc., Helicoid Gage Division 1425
American Time Products, Inc. 1348
AMP, Incorporated 1307
Annin Company 1344, 1345
Assembly Products, Inc. 1447
Associated Research, Incorporated 1418
Automatic Electric Sales Corporation 1317

Bailey Meter Company 1346
Baird-Atomic, Inc. 1312
Barksdale Valves 1403
Barton Instrument Corporation 1342
Bayley Instrument Co. 1448
B-I-F Industries, Inc.— Builders-Providence, Inc. 1400, 1401
B-L-H: Electronics & Instrumentation Division 1332
Borg Corporation, George W. 1398, 1399
Bourns Laboratories, Inc. 1335
Brailsford & Co., Inc. 1444
Breeze Corporations, Inc. Inside Back Cover
Bridgeport Thermostat Division 1323
Bristol Company 1326, 1327, 1407
Brookfield Engineering Laboratories 1278
Builders-Providence, Inc.— B-I-F Industries, Inc. 1400, 1401
Burgess Battery Company 1405
Burroughs Corp. 1339

Callery Chemical Company 1448
Chatillon & Sons, John 1445
Coleman Engineering Company, Inc. 1402
Colvin Laboratories, Inc. 1382
Comar Electric Company 1436
Conoflow Corporation 1337
Consolidated Electrodynamics Corporation 1286, 1319, 1336
Cox Instrument Division, Nankervis Co., George L. 1433
Crawford Fitting Company 1293
Crescent Insulated Wire & Cable Co. 1391
Crystal Glass Tube & Cylinder Co. 1409
Cubic Corporation 1383
Curtiss-Wright Corporation 1341

Dahl Company, Inc., George W. 1316
Datex Corporation 1282
Davis Instruments 1397
DeZurik Corporation 1310
Diehl Manufacturing Company 1280
Dynamic Instrument Company 1404

Eagle Signal Corporation 1325
Eclipse Fuel Engineering Co., Seico Instrument Division 1329
Edison Industries, Inc., Thomas A., Instrument Division 1321
ElectroData—Division of Burroughs Corporation 1309
Electronic Associates, Inc. 1384
Electronics & Instrumentation Division, B-L-H 1332
Engelhard Industries, Inc. 1311
Eppley Laboratory, Inc. 1411
Epsco, Incorporated 1318
Esterline-Angus Company, Inc. 1446

Fairchild Engine & Airplane Corporation, Stratos Industrial Products Branch 1423
Farris Affiliated Companies 1281
Falstrom Company 1279
Fisher Governor Company 1290, 1291, 1305
Foxboro Company 1297, 1349
Freed Transformer Co., Inc. 1440

General Electric Company 1295
General Precision Equipment Corporation 1314, 1315
Gow-Mac Instrument Co. 1414
Gubelman Charts, Incorporated 1433

Hammel-Dahl Company Outside Back Cover
Hasler-Tel Co., Inc. 1440
Heiland Division, Minneapolis-Honeywell Regulator Co. 1330, 1331
Heise Bourdon Tube Company, Inc. 1443
Helicoid Gage Division, American Chain & Cable Co., Inc. 1425
H. J. J. Company 1416
Hoke Incorporated 1405

Illinois Testing Laboratories, Inc. 1407
Imperial Brass Mfg. Co. 1283
Industrial Electronic Engineers 1274
Industrial Instruments Engineering Corp. 1441
Industrial Pyrometer and Supply Co. 1412
Instrument Service Engineering Labs. 1448

Jones Optical Works, A. D. 1432
Judson Bigelow, Inc. 1433

Kin Tel 1333

Leach Corporation 1299
Leeds & Northup Company 1350
Lenox Instrument Co. 1433
Leslie Co. 1372
Levin & Son, Inc., Louis 1411
Lewis Engineering Co. 1273
Liquidometer Corp. 1432
Lynn, Robert M. 1406

Manning, Maxwell & Moore, Inc. 1288, 1289, 1334, 1347, 1395, 1413
Marconi Instruments 1421
Marsh Instrument Co. 1430
Marshalltown Mfg. Company 1301
Measurements 1420
Mercoid Corporation 1436
Mine Safety Appliances Company 1308
Minneapolis-Honeywell 1284, 1300, 1322, 1393
Moeller Instrument Company 1296
Moseley Co., F. L. 1440
Moser Jewel Company 1430

Nankervis Co., George L., Cox Instruments Div. 1438
Nash Engineering Company 1340
Newark Electric Company 1406
New Hermes Engraving Machine Corp. 1431
Northam Electronics, Inc. 1415

Offner Electronics, Inc. 1304
O. K. Machine & Tool Corporation 1442
Oster Manufacturing Company, John 1338

Pace Engineering Company 1407
Panellit, Inc. 1437
Partlow Corp. 1276
Petrometer Corporation 1431
Philbrick Researches, Inc., George A. 1343
Plummer and Kershaw 1430
Post Electronics Division of Post Machinery Co. 1416
Potter Instrument Company, Inc. 1378
Precision Tube Company 1424
Preis Engraving Machine Co., H. P. 1415
Premier Metal Products Company 1422
P-W Industries, Inc. 1423

Radio Frequency Laboratories, Inc. 1434
Renick Co., L. C. 1446
Research Controls 1420
Rockwell Company, W. S. 1397, 1427
Rosemount Engineering Company 1435

Sanborn Company 1313
Seico Instrument Division, Eclipse Fuel Engineering Co. 1329
Sensitive Research Instrument Corporation 1274
Servo-Tek Products 1439
Shore Instrument & Mfg. Co., Inc. 1446
Simplatrol Products Corp. 1432
Skinner Electric Valve Division 1292
Smith Company, S. Morgan 1428
Southwestern Industrial Electronics Company 1301
Stewart Corporation, F. W. 1444
Stitch Co., Inc., Herman H. 1420, 1422
Stratos Industrial Products Branch, Fairchild Engine & Airplane Corporation 1423
Stromberg-Carlson 1429
Swartwout Company 1277
Swiss American Jewel Bearings Co. 1415

Technique Associates, Inc. 1408
Tenney Engineering, Inc. 1287
Thermo Electric, Inc. 1396
Tigerman Engineering Company 1410
Trimount Instrument Company 1403

Uehling Instrument Co. 1414
Unertl Optical Co., John 1444
Uniflow Valve Corporation 1377
United Electric Controls Company 1298
United States Testing Company, Inc. Inside Front Cover
Universal Relay Corp. 1416

Van Products Co. 1418
Veeder-Root, Incorporated 1320

Wallace & Tiernan, Incorporated 1419
Waugh Engineering Co. 1418
West Instrument Corporation 1417
Weston Electrical Instrument Corporation, a Subsidiary of Daystrom, Incorporated 1302, 1303
Westronics, Incorporated 1324
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NEW LITERATURE

PRECISION GEARS. 4-page brochure illustrates different types of "UQ" fine-pitch precision gears from 300 to 24 diametral pitch, from 0.0625" dia up.—Western Gear Corp., Box 182, Lynwood, Calif.
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FABRICATION AND FACILITIES

FURNACES. 12-page brochure describes seven series of high-temperature furnaces from miniature-tubular to large-chamber models; also control instrumentation.—Lucifer Furnaces, Inc., Neshaminy, Penna.
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ALUMINUM SOLDERING FLUX. 4-page pocket-size bulletin describes a new flux said to promote capillary action on aluminum; can be used to join aluminum to aluminum or aluminum to other metals.—American Solder & Flux Co., 19th & Willard Sts., Phila. 40, Pa.
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AUTOMATIC GRINDER CONTROLS for ID, OD, and surface grinding are illustrated and described in a 4-page folder, Form 3R3342.—Electronic Products Div., Radio Corp. of America, Camden 2, N. J.
For more information circle **492** on inquiry card.

TOROIDAL WINDER. 4-page brochure describes electronically-controlled Model TW 300 Toroidal Winder.—Boesch Mfg. Co., Danbury, Conn.
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FACILITIES. 24-page brochure describes company's facilities and products.—Coleman Engineering Co., Inc., 3500 Torrance Blvd., Torrance, Calif.
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MISCELLANEOUS

ULTRASONIC CLEANING. 24-page Bulletin S-200, explains practical applications and basic principles of ultrasonic cleaning.—Branson Ultrasonic Corp., 40 Brown House Rd., Stamford, Conn.
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SMALL SCREW MACHINE PARTS. 4-page bulletin describes company's facilities and covers typical products.—Precision Metal Products Co., 41 Elm St., Stoneham 80, Mass.
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PRESSURE PICKUPS. 2-page bulletin describes six new models of variable-resistance type pickups for ranges from 0-5 to 0-15000 psi.—Decker Engineering Corp., 7706 Melrose Ave., Los Angeles 46, Calif.
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CHARTING AND LAYOUT. 12-page Bulletin GP-5 describes Graph-A-Plan, a new concept of materials and methods for the preparation of charts and layouts used in business and industry.—Labelon Tape Co., Inc., 450 Atlantic Ave., Rochester 9, N. Y.
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LUBRICANTS. 8-page pocket-size Bulletin 116 contains a chart for machine shop personnel to show where and how Molykote Lubricants should be applied.—The Alpha-Molykote Corp., 65 Harvard Ave., Stamford, Conn.
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5	25	45	65	85	105	125	145	
6	26	46	66	86	106	126	146	
7	27	47	67	87	107	127	147	
8	28	48	68	88	108	128	148	
9	29	49	69	89	109	129	149	
10	30	50	70	90	110	130	150	
11	31	51	71	91	111	131	151	
12	32	52	72	92	112	132	152	
13	33	53	73	93	113	133	153	
14	34	54	74	94	114	134	154	
15	35	55	75	95	115	135	155	
16	36	56	76	96	116	136	156	
17	37	57	77	97	117	137	157	
18	38	58	78	98	118	138	158	
19	39	59	79	99	119	139	159	
20	40	60	80	100	120	140	160	

Products Reported Editorially

201	221	241	261	281	301	321	341	361	381	401	421	441	461	481
202	222	242	262	282	302	322	342	362	382	402	422	442	462	482
203	223	243	263	283	303	323	343	363	383	403	423	443	463	483
204	224	244	264	284	304	324	344	364	384	404	424	444	464	484
205	225	245	265	285	305	325	345	365	385	405	425	445	465	485
206	226	246	266	286	306	326	346	366	386	406	426	446	466	486
207	227	247	267	287	307	327	347	367	387	407	427	447	467	487
208	228	248	268	288	308	328	348	368	388	408	428	448	468	488
209	229	249	269	289	309	329	349	369	389	409	429	449	469	489
210	230	250	270	290	310	330	350	370	390	410	430	450	470	490
211	231	251	271	291	311	331	351	371	391	411	431	451	471	491
212	232	252	272	292	312	332	352	372	392	412	432	452	472	492
213	233	253	273	293	313	333	353	373	393	413	433	453	473	493
214	234	254	274	294	314	334	354	374	394	414	434	454	474	494
215	235	255	275	295	315	335	355	375	395	415	435	455	475	495
216	236	256	276	296	316	336	356	376	396	416	436	456	476	496
217	237	257	277	297	317	337	357	377	397	417	437	457	477	497
218	238	258	278	298	318	338	358	378	398	418	438	458	478	498
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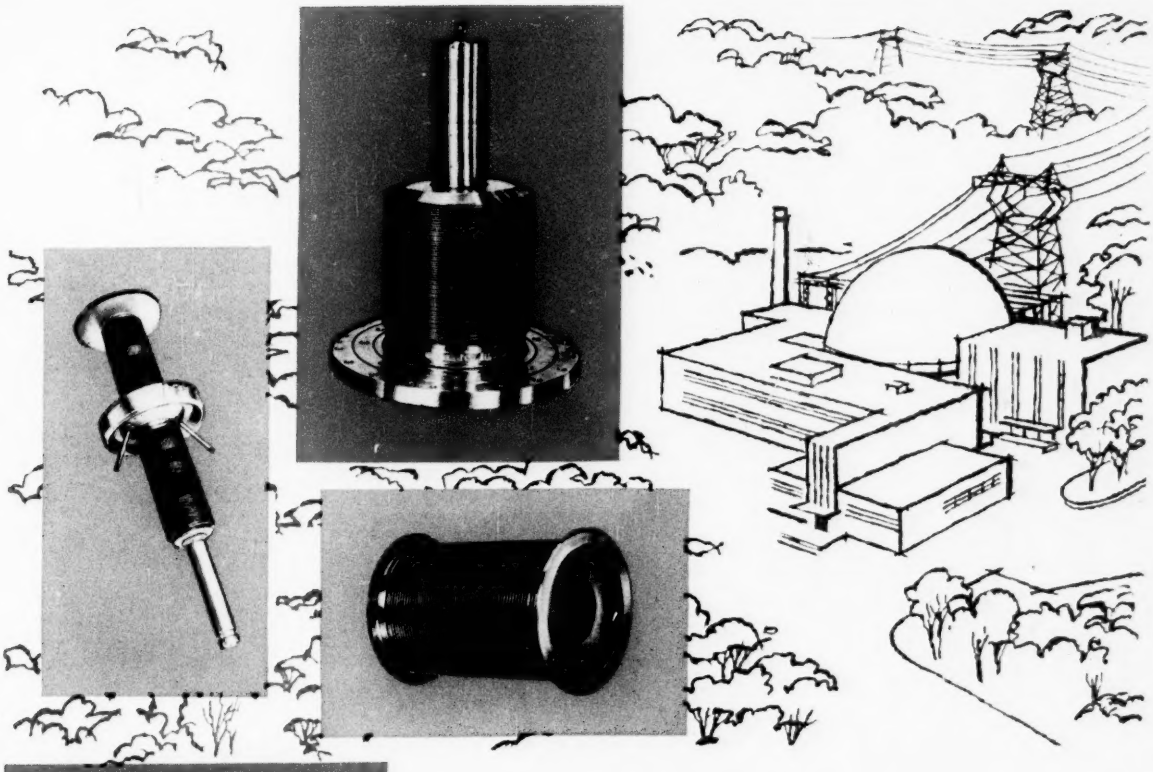

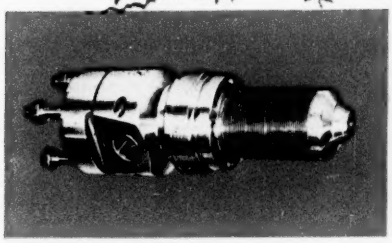

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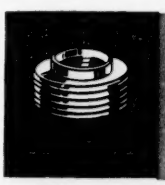

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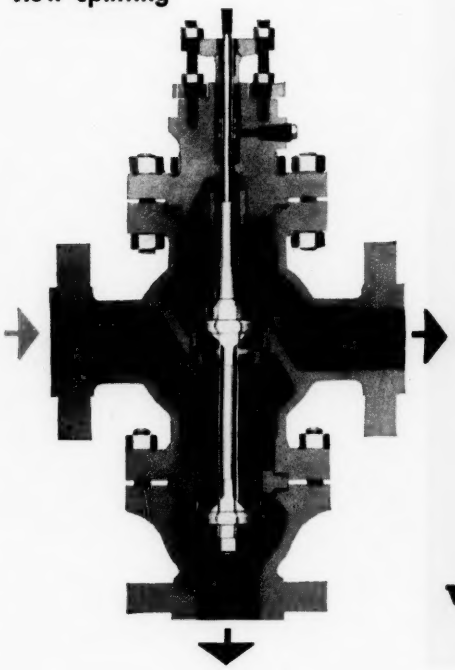

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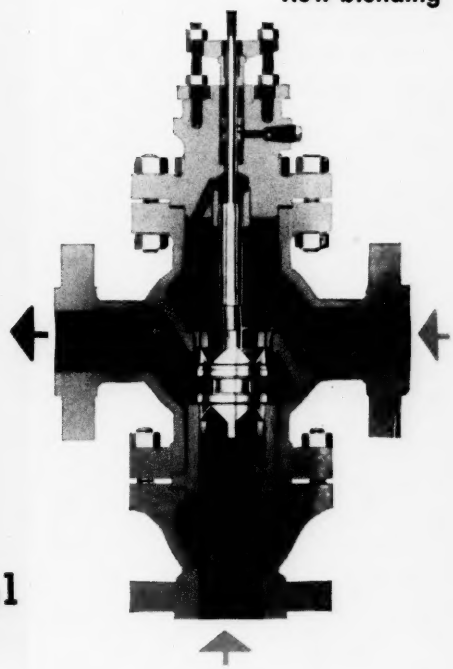

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